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ABSTRACT

This book of pretests and review exercises is designed to accompany the Engine Tune-Up Service Student Guide for Unit 4, Secondary Circuit, available separately as CE 031 214. Focus of the exercises and pretests is testing and servicing the secondary ignition circuit. Pretests and performance checklists are provided for each of the seven performance objectives contained in the unit. There are 22 review exercises that are short check-ups to let the student know how well she/he has learned the material for one or more work activities covered in the Student Guide. Answers to all of the exercises are found at the back of the book. (YLB)

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ENGINE TUNE-UP SERVICE

Unit 4: Secondary Circuit

Review Exercise Book

Automotive Mechanics Curriculum

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HOW TO USE THIS BOOK

In this Review Exercise Book, you'll find pretests and review exercises. These tests and exercises cover the material in the Student Guide. The Student Guide will tell you when to do a review exercise, so don't start doing any of these exercises just yet.

PRETESTS

You will take the pretest for Performance Objective 16 before you start working through the Student Guide. A pretest is a test designed to help you and your instructor find out what you already know. The questions on the pretest may also be used to help you review what you've learned after studying the material and doing the activities.

REVIEW EXERCISES

A review exercise is a short checkup that lets you know how well you've learned the material for one or more work activities covered in the Student Guide. It is a way of testing yourself. The answers to all the exercises are in the back of this book.

You might be tempted to turn to the answers before you complete the questions, but if you do, you'll be the loser—for two reasons. In the first place, automotive mechanics is a skilled and dangerous trade. You need to know what you're doing and how to do it safely without having to check the book on every step. If you don't learn the material well, you can hurt yourself or damage the vehicle. In the second place, you'll eventually be graded by your instructor on how well you can do a performance objective. So if you look at the answers first, you'll just be wasting your time.

After you answer all the questions in a review exercise, check your answers against the ones in the back of the book. Review the material in the Student Guide for any question you have trouble with. Talk with your instructor if you're still unsure about any of the material covered in the Student Guide.

FINAL TESTS

These are the only two tests on which you'll be graded. One of the tests will be a written test, and the other will be a performance test. If you've studied the material in the Student Guide, and if you've done the exercises and work activities as required, you'll have no trouble doing well on these final tests. You may even find them easy and fun to complete.

Now turn to the next page and complete the pretest for Performance Objective 16.

PRETEST—P.O. 16: Inspect and Replace Ignition Wires, Cap, and Rotor

NAME _____

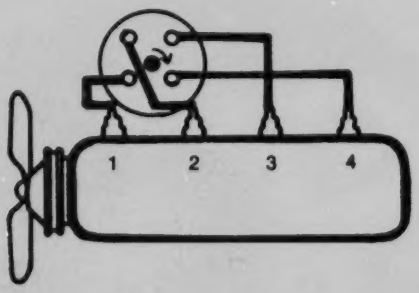
1. Check (✓) each safety practice listed below that you should follow.
   - _____ a. Keep long hair under a cap.
   - _____ b. Keep clothing extra loose for ease of movement.
   - _____ c. Wipe distributor cap and area clean before removing cap.
   - _____ d. Use the correct tool when replacing ignition wires.
   - _____ e. Wear metal jewelry on one arm only.
   - _____ f. Avoid making electrical tests in wet areas.

2. Which type of secondary wire would you most likely find on a 1952 Studebaker?
   - _____ a. metallic conductor type
   - _____ b. nonmetallic conductor type

3. Secondary wires with dirt or oily spots on them should be:
   - _____ a. cleaned
   - _____ b. replaced

4. Cross-firing can best be corrected by:
   - _____ a. routing secondary wires so they touch each other
   - _____ b. routing secondary wires so they are parallel and touch each other
   - _____ c. routing secondary wires so they are parallel and do not touch each other
   - _____ d. routing secondary wires in a crisscross manner

5. Look at the picture of the engine below.



Is the wiring correct for a 1-4-3-2 firing order?
   - _____ a. Yes
   - _____ b. No

6. Which of the following descriptions is correct for removing a spark plug wire?
   - _____ a. Twist the wire; then pull the wire out at an angle.
   - _____ b. Twist the boot; then pull the boot straight out.
   - _____ c. Twist the boot; then pull the boot out at an angle.
   - _____ d. Pull the wire straight out by the boot.

7. What should you do before removing any high-tension wires from the distributor cap?

_____ a. Examine the distributor cap for cracks.
_____ b. Mark the position of the #1 spark plug wire on the cap.
_____ c. Check the continuity of the wires.
_____ d. Remove the other ends of the wires from the spark plugs.

8. One correct action to take if the metal clips in the high-tension wires are loose is to:

_____ a. repair the clips
_____ b. replace the clips

9. Which of the following materials can be used to clean corroded terminal clips on high-tension cables?

_____ a. a screwdriver
_____ b. a hacksaw
_____ c. a knife
_____ d. wire stripper pliers
_____ e. a fiber brush

10. The chart below is from a technical service manual.

WIRE LENGTH	RESISTANCE (ohms)	
	Minimum	**Maximum**
0-15 inches	3,000	10,000
15-25 inches	4,000	15,000
25-35 inches	6,000	20,000
above 35 inches	—	25,000

According to the chart, what should you do with a 12-inch wire that measured 15,000 ohms resistance?

_____ a. Replace the wire.
_____ b. Install the wire.

11. If no specifications exist for a vehicle's secondary wires, what figure would you use for maximum resistance?

_____ a. 10,000 ohms
_____ b. 15,000 ohms
_____ c. 20,000 ohms
_____ d. 25,000 ohms

12. The steps below for replacing secondary wires are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	**Steps**
1. _____	a. Remove old wire.
2. _____	b. Match old wire length to new wire length.
3. _____	c. Mark the position of the #1 spark plug wire on the distributor cap.
4. _____	d. Make an operational check of wire performance.
5. _____	e. Set the wire into the clips or looms.
6. _____	f. Route new wire in place of old wire.

13. When ready-made secondary wires are not available, what tools should you use to make secondary wires?

_____ a. wire stripper and crimping tool
_____ b. soldering iron, pliers, and wire cutters
_____ c. pliers, wire strippers, and soldering iron

14. Flashover in a distributor cap is usually caused by:

_____ a. grease or dirt on the cap
_____ b. cracks in the cap

15. When you detect signs of burned or grooved terminal posts inside the distributor cap, you should:

_____ a. clean the cap
_____ b. replace the cap

16. Whenever the distributor cap is replaced, you should:

_____ a. also replace the rotor
_____ b. also clean the rotor

17. What is the easiest procedure for installing a new distributor cap?

_____ a. Exchange wires one by one from old cap to new cap, then install new cap.
_____ b. Install new cap, then exchange wires one by one from old cap to new cap.
_____ c. Pull all the wires from the old cap, install new cap, and attach all wires.
_____ d. Pull all the wires from the old cap, attach all wires, and then install new cap.

18. Check all the operations you should perform when checking the installation of new secondary wires or of cap and rotor.

_____ a. Visually inspect all wiring to check for tight connections.
_____ b. Start engine to check smoothness of operation.
_____ c. Pull each wire, one by one, from the distributor to check performance.
_____ d. Check for smooth operation while accelerating and decelerating.

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 1

1. In the ignition system, the circuit that carries the coil's stepped-up voltage to the spark plugs is called the _____ .

2. The part that fires the air-fuel mixture in the engine cylinder is called the _____ _____ .

3. The main parts that make up the secondary circuit are:

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

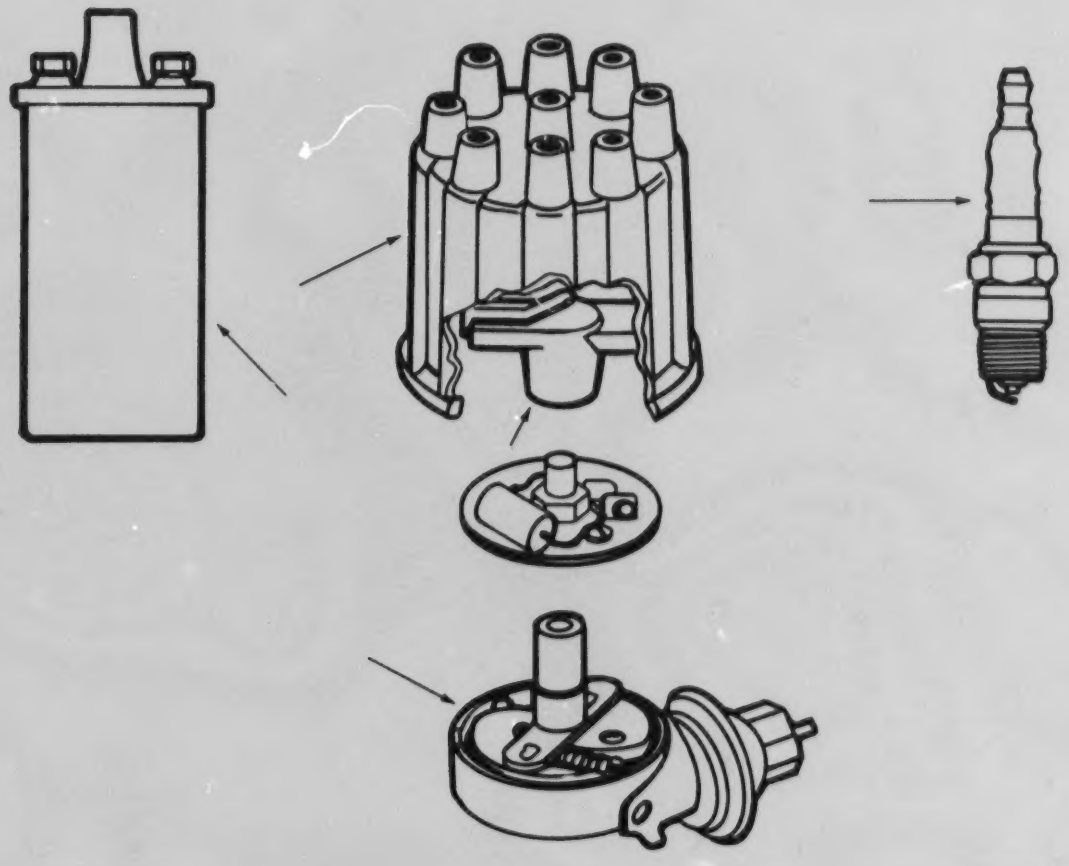
   f. _____

4. The coil high-tension cable or lead connects to the _____ tower of the distributor cap.

5. The part in the distributor that directs the high-voltage current to the right spark plug cable at the right time is called the _____ .

6. The spark plug high-tension cables are arranged in the distributor cap according to the manufacturer's _____ .

7. In the illustration below, (1) draw the secondary circuit wiring, connections, and grounds, and (2) label each part at the arrows.



Now turn to the back of this book and check your answers for Exercise 1.

PERFORMANCE CHECKLIST—P.O. 16

Your instructor will provide either a live vehicle or shop engine for this objective. Inspect and replace the ignition wires, distributor cap, and rotor. All necessary tools, equipment, and manuals will be made available.

Student Performances

1. Visually inspects secondary wires and notes any defects.
2. Removes each secondary wire and tests resistance; records results and reinstalls or replaces as necessary.
3. Visually inspects distributor cap and rotor, and notes any defects.
4. Reinstalls or replaces cap and rotor as necessary.
5. Uses proper tools and equipment.
6. Follows appropriate safety precautions.
7. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable		Not Acceptable		Omit

Keep a copy of this checklist for your records.

PRETEST—P.O. 17: Clean, Gap, and Install Spark Plugs

NAME _____

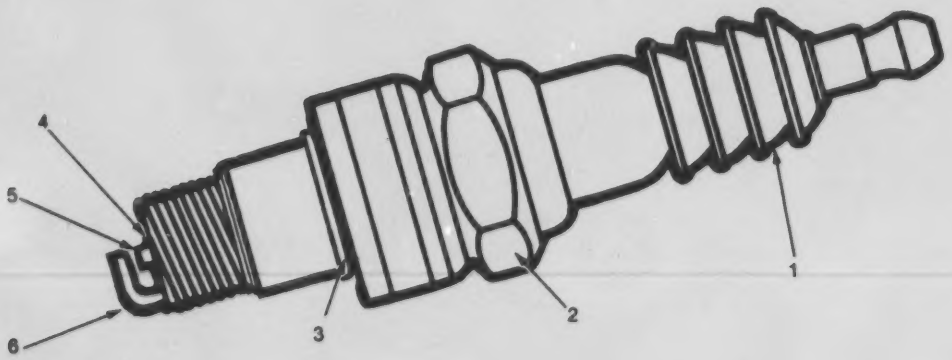
1. Check (✓) each safety practice listed below that you should follow.
   - _____ a. Keep all metal jewelry on one hand or arm only.
   - _____ b. Use fender covers when working under the hood.
   - _____ c. Select the correct tools for removing, gapping, and installing spark plugs.
   - _____ d. Grip spark plug wires by the boot, not the wire.
   - _____ e. Always wear eye protection when working with compressed air.

2. Which of the following conditions of a spark plug wire requires the wire's replacement?
   - _____ a. oil, dirt, or grease on the wire
   - _____ b. improper wire routing
   - _____ c. nonmetallic conductor core wire used instead of metallic core
   - _____ d. cracked insulation in wire

3. The steps below for removing a spark plug are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Select proper size and type of tools.
2. _____	b. Remove the spark plugs from the engine.
3. _____	c. Blow compressed air around the spark plugs.
4. _____	d. Disconnect spark plug wires.
5. _____	e. Loosen each spark plug one or two turns.

4. Identify each numbered part in the drawing by choosing the proper name from the right-hand list and writing its letter in the correctly numbered blank.



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

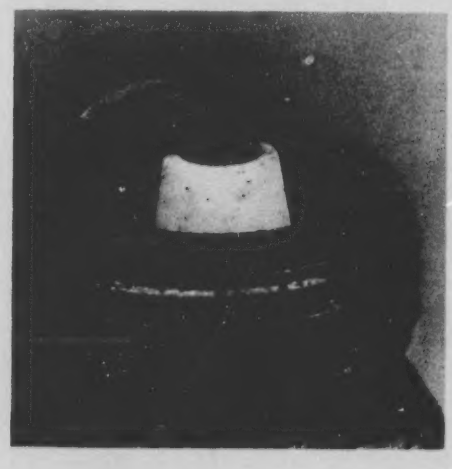
- a. center electrode
- b. carbon tip
- c. ground electrode
- d. porcelain insulator
- e. gasket
- f. insulator
- g. gap spacer
- h. plug hex size

5. Look at this picture of a spark plug.

You should:

_____ a. clean the spark plug and reinstall
_____ b. replace the spark plug

6. Look at this picture of a spark plug.



You should:

_____ a. clean the spark plug and reinstall
_____ b. replace the spark plug

The following five photographs are reprinted courtesy of Champion Spark Plug Company.

7. Look at this picture of a spark plug.

You should:

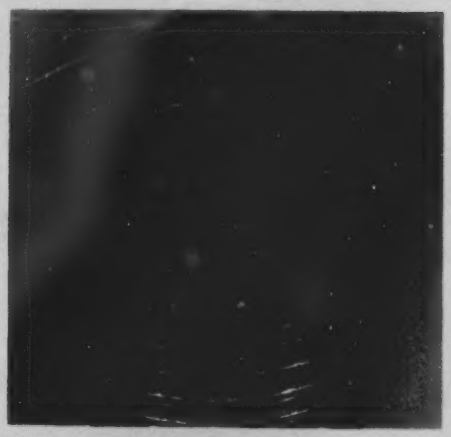
_____ a. clean the spark plug and reinstall
_____ b. replace the spark plug

8. Look at this picture of a spark plug.

You should:

_____ a. clean the spark plug and reinstall
_____ b. replace the spark plug

9. Look at this picture of a spark plug.



You should:

_____ a. clean the spark plug and reinstall
_____ b. replace the spark plug

10. Which of the following answers about how to use a sandblaster for cleaning a spark plug is true?

_____ a. Be sure to move the plug in and out while using the machine.
_____ b. Use the air blast first, and then use the abrasive blast.
_____ c. Use the abrasive blast first, and then use the air blast.
_____ d. The order of air and abrasive blasting doesn't matter.

11. Which of the following statements about gapping a spark plug is NOT true?

_____ a. The gap is correct when the feeler gauge barely touches each electrode.
_____ b. It is best to use only a round wire feeler gauge.
_____ c. Only the ground electrode should be bent.
_____ d. The electrode should be bent only with a special spark plug tool.
_____ e. The spark plug gap should always be checked before installing plugs.

Use the following chart to answer Questions 12-14.

SPARK PLUGS

Gap	040"
Torque	35 ft-lbs.

Spark Plug Type

Application	Number
All Man. Trans.	R45S
All Auto. Trans.	R46S

From *National Service Data Tune-Up (II). Electrical Wiring Diagrams, Accessories and Equipment.* ©1975 Mitchell Manuals, Inc. Used with permission of Mitchell Manuals, Inc.

Assume your car has a 301-inch engine with a 2-barrel carburetor and an automatic transmission.

12. At what gap should you set the spark plugs?

_____ a. .035"
_____ b. .038"
_____ c. .040"

13. What spark plug type would you select for installation?

_____ a. R45S
_____ b. R46S

14. What is the proper torque for installing spark plugs in this engine?

_____ a. 10 ft-lbs.
_____ b. 25 ft-lbs.
_____ c. 35 ft-lbs.
_____ d. 25-35 ft-lbs.

15. If used spark plugs have white blistered insulators and very worn electrodes, this usually indicates that:

_____ a. higher heat-range spark plugs are needed
_____ b. lower heat-range spark plugs are needed
_____ c. the spark plug heat range is okay

16. Which of the following spark plug types would be the "coldest"?

_____ a. UJ-6
_____ b. J-8
_____ c. J-11
_____ d. UJ-12

17. What could possibly happen if you tighten (torque) a spark plug too much?

_____ a. The spark plug can overheat.
_____ b. The spark plug can cause preignition.
_____ c. The spark plug air gap can change.

18. The steps below for installing spark plugs are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Install the plugs finger-tight.
2. _____	b. Install gaskets on the spark plugs.
3. _____	c. Wipe the spark plug seats clean in the cylinder head.
4. _____	d. Wipe insulators clean and attach wires.
5. _____	e. Torque each spark plug to specifications.

19. Which of the following methods should be used for checking spark plug operation?

_____ a. Pull all spark plug wires at once by hand.
_____ b. Using insulated pliers, pull all spark plug wires at once.
_____ c. One by one, pull spark plug wires by hand.
_____ d. Using insulated pliers, pull and replace spark plug wires one by one.

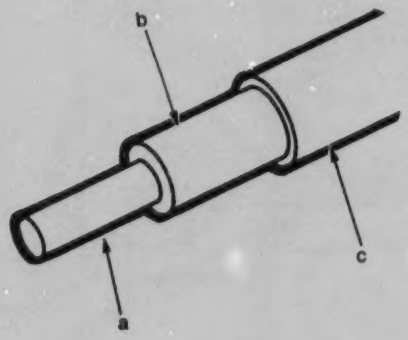
20. Which of the following results indicates proper spark plug operation?

_____ a. smoother engine idle when spark plug wire is pulled
_____ b. rougher engine idle when spark plug wire is pulled

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 2

1. A condition describing the travel of current or high voltage from one terminal to another or to ground, by mistake, is called _____.
2. A path allowing current to travel from one terminal to another by mistake is called a _____.
3. Why should you not remove distributor caps where dirt has collected? _____ _____.
4. Why should you not replace ignition wires without following recommended procedures or without using the correct tools? _____.
5. Secondary wires are also called _____ cables or _____ _____ cables.
6. Name the parts of the secondary wire shown in the illustration below.



   a. _____
   b. _____
   c. _____

7. Today, secondary wires are nonmetallic and have a conductor or core made from _____ and _____ particles.
8. Secondary wires should be kept away from _____, from _____ places, and from _____ manifolds.
9. Secondary wires may be cleaned with a _____ and a mild _____.

For questions 10-16, write *T* in the blank if the statement is true, and *F* if the statement is false.

10. _____ Secondary wire insulation that is cracked and dry must be replaced.

11. _____ Secondary wires that are soaked with oil or grease should be replaced.

12. _____ Secondary wires that have cuts or breaks should be replaced.

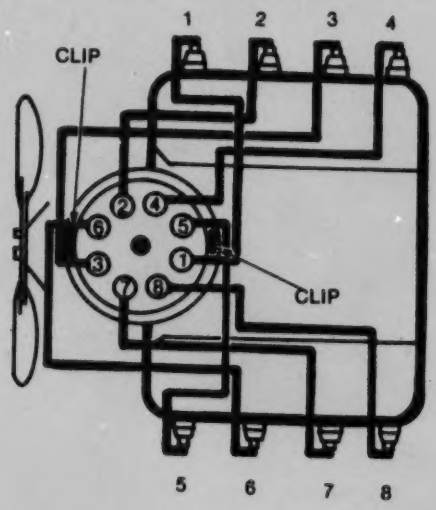
13. _____ Improper routing of secondary wires can cause cross-firing.

14. _____ Cross-firing occurs when the spark from one wire transfers to another wire lying next to it.

15. _____ "Firing order" describes the numerical order in which the cylinders fire the fuel charge.

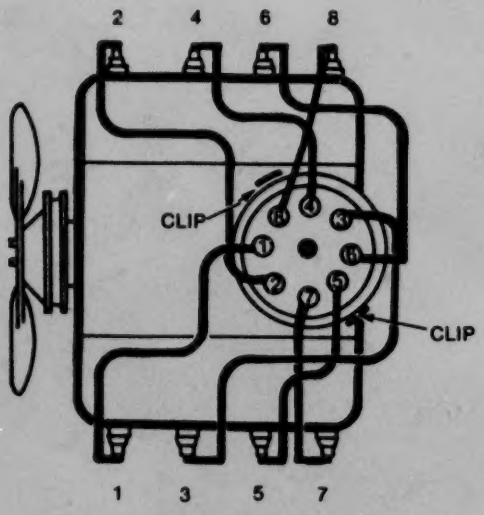
16. _____ Secondary wires that are connected in an incorrect firing order will cause the engine to "miss."

17. The firing order of this V-8 engine is _____.



Adapted from *Motor Auto Repair Manual 1975*. 38th Edition. ©1974 The Hearst Corporation. Used with permission of Motor Publications.

18. The firing order of this V-8 engine is _____.



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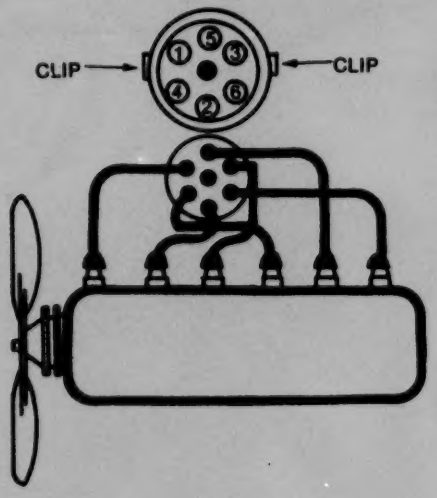
19. The firing order of this 6-cylinder engine is _____.



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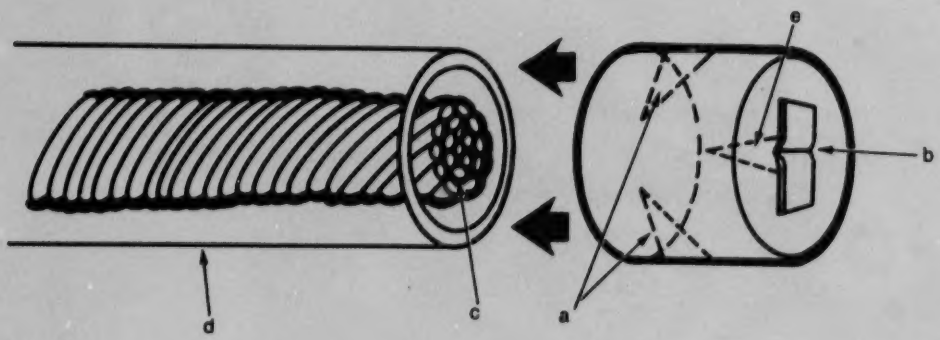
Now turn to the back of this book and check your answers for Exercise 2.

EXERCISE 3

1. Before you try to remove the secondary wire from the spark plug, you must first _____ the rubberlike boot back and forth.
2. The rubberlike boot on the secondary wire forms a _____ around the spark plug.
3. Before you try to remove the secondary wire from the distributor cap, you first _____ the nipple from around the tower of the cap.
4. If the engine is hot, you should remove the secondary wire from the spark plug, using _____ _____.
5. Before removing any secondary wires, you should mark the _____ _____ _____ wire location on the distributor cap.
6. In the blanks below, name the parts indicated in the illustration, which shows the terminal end of the secondary wire that fits into the distributor cap.



   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

7. The terminal ends of the secondary wires must be checked for the following conditions:
   a. _____
   b. _____
   c. _____
8. High-tension wire resistance specifications are based on wire _____.
9. A secondary wire that tests too high in resistance (ohms) indicates a possible _____ wire.

For question 10, write *T* in the blank if the statement is true, and *F* if the statement is false.

10. _____ Generally, a wire that tests at less than 20,000 ohms is considered to be okay.

Now turn to the back of this book and check your answers for Exercise 3.

EXERCISE 4

For the following questions, write *T* in the blank if the statement is true, and *F* if the statement is false.

1. _____ Some secondary wire sets are factory-made, with the wires precut to proper lengths.
2. _____ Some secondary wire sets require that each spark plug wire be fitted to its correct length.
3. _____ Before installing or changing secondary wires, you should mark the position of the #1 spark plug wire on the distributor cap.
4. _____ To be sure the new wire is the same length as the old, you should lay one against the other before cutting the new one.
5. _____ Secondary wires should be replaced or installed all at one time so you don't mix up the firing order.
6. _____ Secondary wires should be properly routed and replaced in their clips or looms.
7. _____ Secondary wires should be routed away from heated, vibrating, or moving parts.
8. _____ Metal clips for secondary wires for the distributor cap end come in various shapes that require different installation procedures.
9. _____ You should always make an operational check after you install secondary wires.

Now turn to the back of this book and check your answers for Exercise 4.

EXERCISE 5

For the following questions, write *T* in the blank if the statement is true, and *F* if the statement is false.

1. _____ High-voltage secondary current can cause rotor and distributor cap terminals to erode and burn out.
2. _____ A distributor cap that is greasy and dirty on the outside can become a path through which high-voltage current can escape.
3. _____ Flashover occurs when the current crosses from one terminal to another.
4. _____ A distributor cap that is greasy and dirty on the inside can become a path through which high-voltage current can pass to another terminal.
5. _____ If the rotor contact at the center of the distributor cap has burned away, the cap can be cleaned and saved.
6. _____ When the distributor cap terminal posts have become badly grooved, the cap should be replaced.
7. _____ If the rotor tip has burned down, the rotor should be replaced.
8. _____ If the rotor contact spring has become heavily grooved, the rotor should be replaced.
9. _____ When you replace a distributor cap, the secondary wires should be transferred from the old cap one wire at a time.

Now turn to the back of this book and check your answers for Exercise 5.

EXERCISE 6

1. Why should you never clean, gap, and replace spark plugs without following the recommended procedures and using the correct tools?

   _____

2. The steps used when you remove a spark plug are given below.

   In the space provided, number the steps in their proper order.

   _____ a. Disconnect the spark plug wire.
   _____ b. Select the proper spark plug socket, ratchets, extensions, and so on.
   _____ c. Use compressed air to blow away the dirt from around the spark plugs and away from the engine.
   _____ d. Loosen each spark plug one or two turns.
   _____ e. Remove the spark plugs from the engine.

For questions 3-8, write *T* in the blank if the statement is true, and *F* if the statement is false.

3. _____ Use of the wrong spark plug tool can cause the breakage of a spark plug insulator.

4. _____ You should use a pair of insulated pliers to pick up a hot spark plug.

5. _____ The purpose of loosening each spark plug before you blow away any dirt is to prevent the dirt from falling inside the engine once the spark plugs are removed.

6. _____ Spark plugs that have tapered seats do not use gaskets.

7. _____ Spark plugs are set in metal tubes on some slant-6 engines.

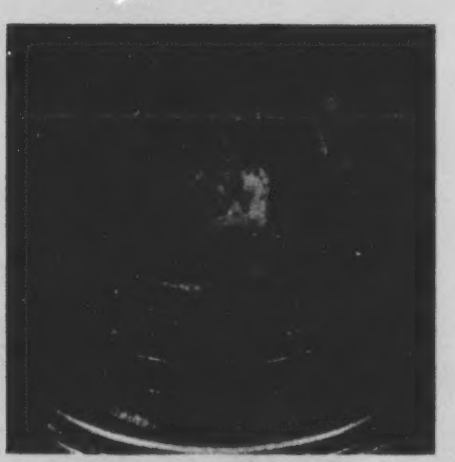
8. _____ As you remove spark plugs, set them in a tray or holder, separating and arranging them by cylinder.

The illustrations for Questions 9-14 show the spark plug defects. Place a check (✓) in the proper blank for each question to show whether the spark plug can be cleaned, regapped, and reused, or whether it should be replaced with a new plug.

The following six photographs are reprinted courtesy of Champion Spark Plug Company.

	Defects			
9.	Melted electrodes and/or blistered insulator		CLEAN	REPLACE

10.



Electrodes burned bluish; dark spots on insulator

CLEAN _____ REPLACE _____

11.

Light deposits (tan or gray)

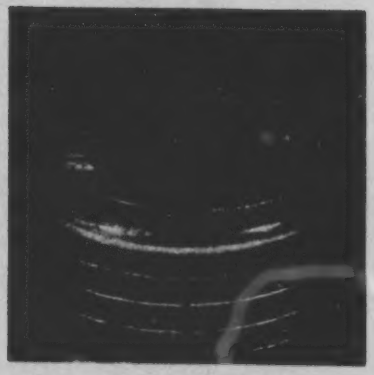
CLEAN _____ REPLACE _____

12.

Electrodes eroded

CLEAN _____ REPLACE _____

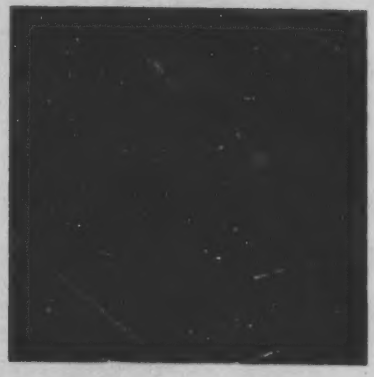
13.



Wet, sludgy deposits

CLEAN _____ REPLACE _____

14.



Dark to yellowish deposits; glazed insulator

CLEAN _____ REPLACE _____

Now turn to the back of this book and check your answers for Exercise 6.

EXERCISE 7

For questions 1-12, write *T* in the blank if the statement is true, and *F* if the statement is false.

1. _____ To properly clean spark plugs, you should first clean the threads with a wire brush.
2. _____ If you sandblast a spark plug for too long a time, you can damage the plug.
3. _____ The spark plug should be dried off with compressed air after it has been cleaned.
4. _____ The replacement time for spark plugs depends on the mileage of service and the wear of the electrodes.
5. _____ Generally, spark plugs are replaced in sets.
6. _____ The purpose of filing spark plug electrodes is to restore the clean, sharp edges and flatness.
7. _____ Less voltage is required for electricity to jump across flat, parallel electrodes than across rounded electrodes.
8. _____ After the electrodes have been filed, the air gap between them must be set to the manufacturer's specifications.
9. _____ Before you set the spark plug gap, you should look up the vehicle manufacturer's specifications.
10. _____ When you measure the spark plug gap opening, you should use a round wire feeler gauge.
11. _____ When you adjust the spark plug gap, you should bend the ground electrode only.
12. _____ When you adjust the spark plug gap, you must use a special tool.
13. Circle the letter of the correct answer below. The spark plug gap opening is correct when:
    a. the feeler guage just touches the electrodes when passed between them.
    b. the feeler guage "snaps through" the two electrodes.
    c. the feeler gauge passes through without touching the electrodes.
    d. you have to force the feeler gauge between the electrodes.

Now turn to the back of this book and check your answers for Exercise 7.

EXERCISE 8

1. Check (✓) the three things you must do before installing a set of spark plugs.
   _____ a. Select a pair of insulated pliers.
   _____ b. Select the proper spark plug heat range for the engine.
   _____ c. Select the proper spark plug threads.
   _____ d. Look up the recommended spark plug part number given by the vehicle manufacturer.
   _____ e. Look up the spark plug torque specifications.
   _____ f. Select the proper torque wrench.

2. The spark plug heat range is controlled by the _____ of the insulator that is exposed to the heat of combustion in the combustion chamber.

3. The spark plug is a _____ plug when the heat has a short way to travel to the cooling system.

4. The spark plug is a _____ plug when the heat has a long way to travel to the cooling system.

5. The part number of the spark plug is located on the _____ of the plug.

6. To tighten spark plugs properly, a _____ is used.

7. Overtightening a spark plug can change the spark plug _____.

8. Undertightening a spark plug will cause the plug to _____.

9. To properly install spark plugs, you must perform the following steps. Number them in the correct order of installation.
   _____ a. Install the spark plug gasket onto the spark plugs.
   _____ b. Wipe the plug insulators and install the spark plug wires.
   _____ c. Using a torque wrench, tighten the spark plugs to manufacturer's specifications.
   _____ d. Clean the spark plug seats in the cylinder head.
   _____ e. Install the spark plugs finger-tight.

10. To make an operational check following spark plug installations, _____ one spark plug wire at a time while the engine is operating.

11. After you do the action described in Question 10, the engine RPM should _____ each time.

Now turn to the back of this book and check your answers for Exercise 8.

PERFORMANCE CHECKLIST—P.O. 17

Your instructor will provide either a live vehicle or live engine for this objective. Remove, clean, gap, and install a set of spark plugs. All necessary tools, equipment, and manuals will be made available.

Student Performances

1. Removes spark plugs in order from the engine.
2. Examines spark plugs and records any defects.
3. Cleans and files spark plugs, or replaces as necessary.
4. Adjusts spark plug gaps to specifications.
5. Installs spark plugs in engine and torques to specifications.
6. Performs operational check of spark plug performance.
7. Uses correct tools and equipment.
8. Follows all appropriate safety precautions.
9. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

Keep a copy of this checklist for your records.

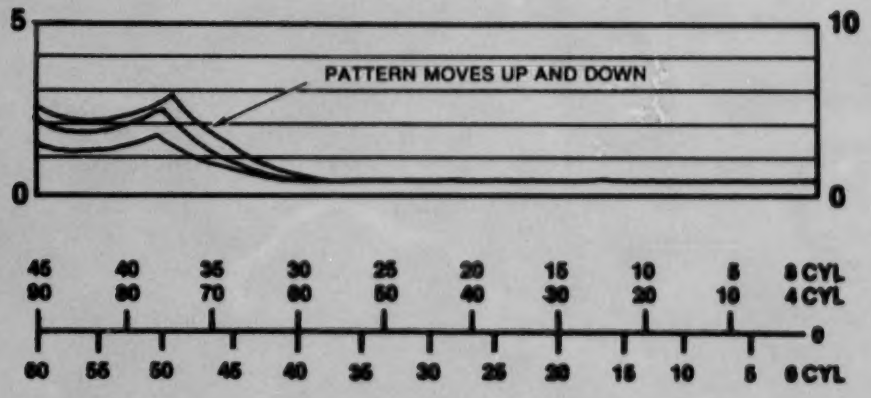
29

PRETEST—P.O. 18: Analyze Engine Performance

Name _____

1. Check (✓) each safety practice listed below that you should follow.
   - _____ a. Do not wear metal jewelry when working on an automobile.
   - _____ b. Always route scope leads away from moving engine parts.
   - _____ c. Follow test equipment manufacturer's instructions.
   - _____ d. Use fender covers when working under the hood.
   - _____ e. Avoid reaching around an engine without looking.
   - _____ f. Wear extra-loose clothing for ease of movement.

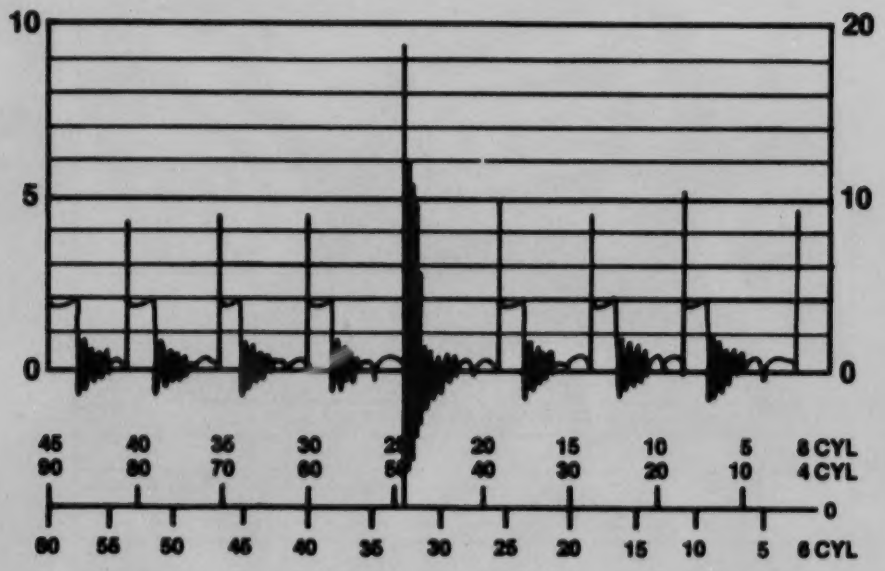
2. Look at the following pattern of an overall secondary ignition test.



Which of the following conditions could cause this pattern?

- _____ a. an opening in the secondary circuit
- _____ b. a normal secondary circuit
- _____ c. a loose coil wire
- _____ d. a shorted coil wire

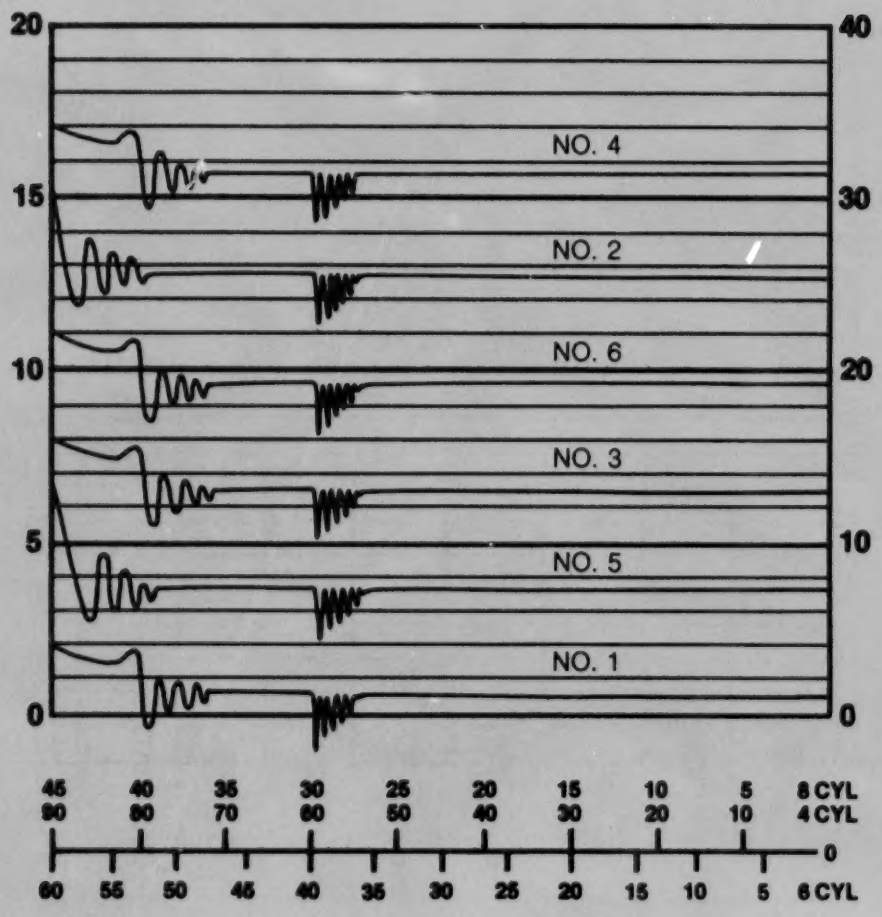
3. Look at the following pattern of an overall secondary ignition test.



Which of the following conditions could cause this pattern?

_____ a. a broken or loose spark plug wire
_____ b. a broken or loose coil wire
_____ c. a normal secondary circuit
_____ d. an incorrect air-fuel mixture in the carburetor

4. Look at the following raster pattern of the secondary circuit.



Which of the following conditions might cause this pattern?

_____ a. a defective spark plug wire
_____ b. narrow spark plug gaps
_____ c. a broken coil wire
_____ d. a defective distributor rotor

5. What is the maximum length of time that a spark plug wire can safely be removed from the spark plug on a vehicle equipped with a catalytic converter?

_____ a. less than 15 seconds
_____ b. less than 30 seconds
_____ c. more than 30 seconds
_____ d. more than 1 minute
_____ e. at least 90 seconds

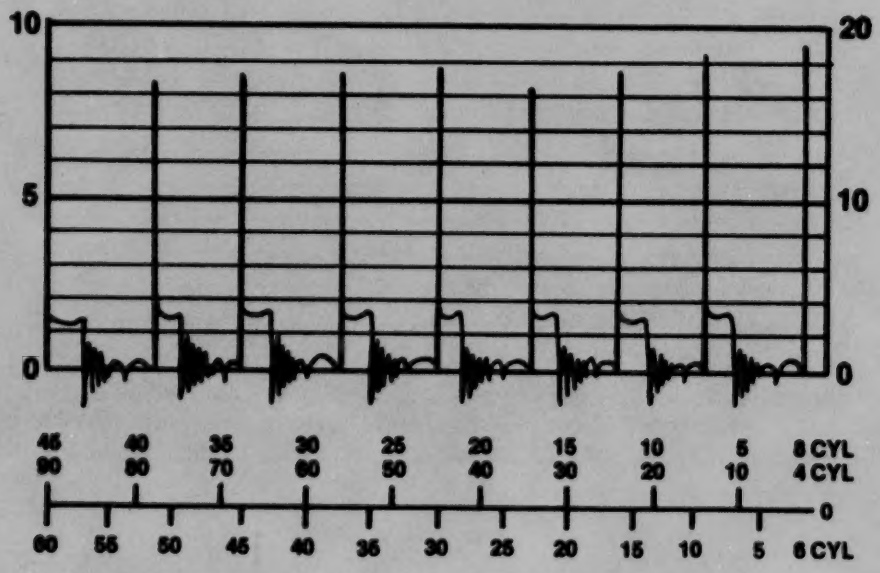
6. As a general rule, what is the minimum acceptable voltage reading for an available coil voltage test?

_____ a. 5 kv
_____ b. 10 kv
_____ c. 15 kv
_____ d. 20 kv
_____ e. 30 kv

7. The secondary ignition circuit insulation test is performed in the same manner as:

_____ a. the snap load test
_____ b. the test for leaky exhaust valves
_____ c. the available coil voltage test
_____ d. the test for a loose coil secondary wire

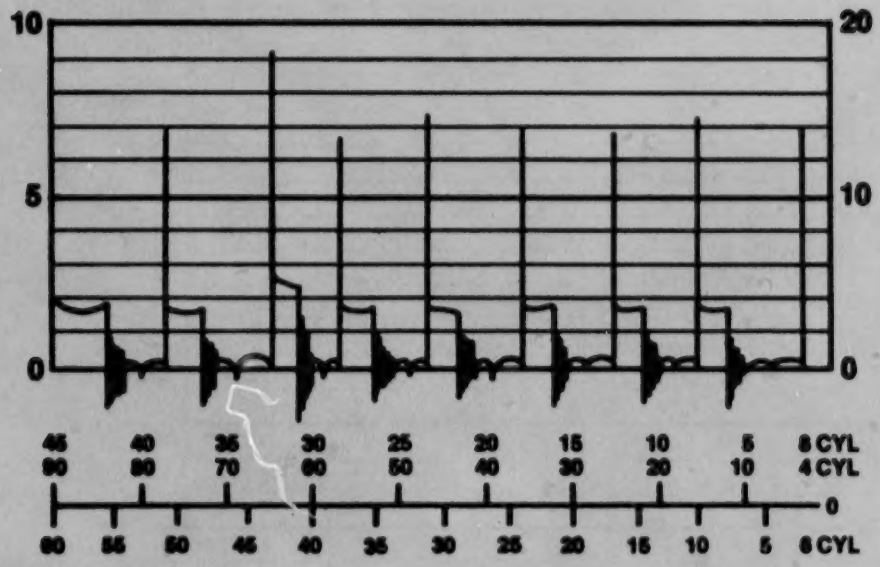
8. Look at the following pattern of a spark plug firing voltage test.



Which of the following conditions could cause this pattern?

_____ a. The coil wire has a break in it.
_____ b. The fuel mixture is too lean.
_____ c. The spark plugs are normal.
_____ d. The ignition timing is late.

9. Look at the following pattern of a spark plug firing voltage test.



Which of the following conditions could cause this pattern?

_____ a. The coil secondary wire is broken.
_____ b. A spark plug is bad.
_____ c. The fuel mixture is too lean.
_____ d. The rotor gap is too small.

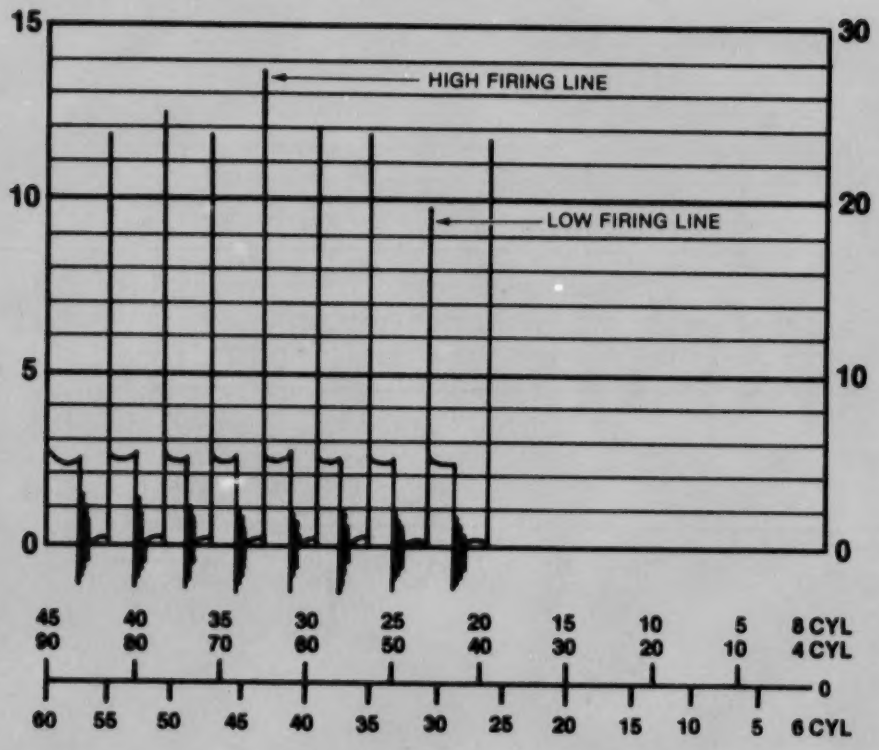
10. After an abnormal firing line is noted in a spark plug firing test, you install a spark plug connector and touch the connector with the scope's resistance test contactor, with one end of the contactor grounded. If the spark line does not fall below 5 kv for the wire in question, what is at fault?

_____ a. the spark plug wire
_____ b. the spark plug
_____ c. the distributor rotor
_____ d. the fuel mixture

11. When making the snap load test, how should the firing voltage lines change on a good engine?

_____ a. They should alternately decrease and increase.
_____ b. They should all rapidly decrease.
_____ c. They should all rapidly increase.
_____ d. They should all spread apart more.

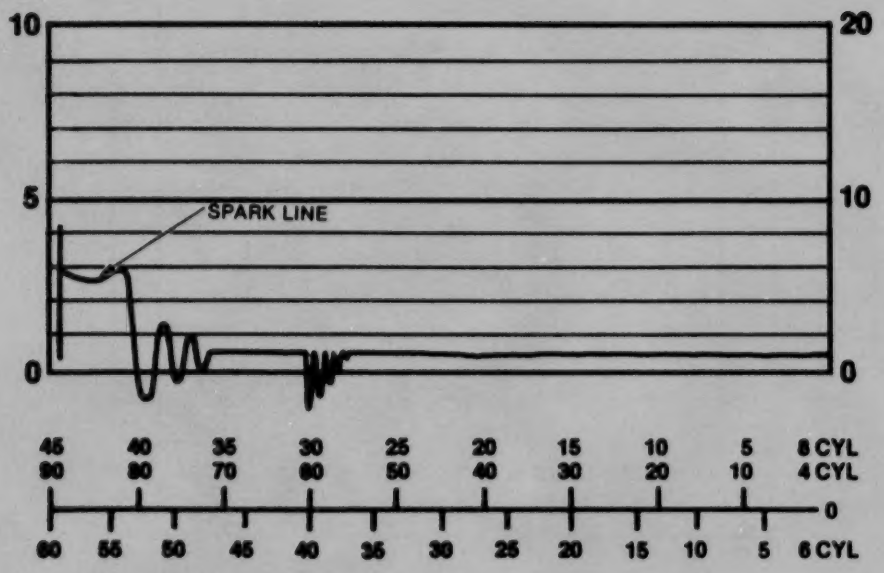
12. Look at the following pattern of a snap load test (firing order).



Which cylinder most likely has a spark plug with too wide a gap?
(Firing order is 1, 5, 4, 2, 6, 3, 7, 8)

_____ a. 1
_____ b. 2
_____ c. 3
_____ d. 4
_____ e. 5
_____ f. 6

13. Look at the following pattern.



Which of the following conditions could cause this pattern?

_____ a. The spark plug gap is too narrow.
_____ b. The spark plug gap is too wide.
_____ c. The spark plug gap is okay.

14. If the firing line of an abnormal cylinder does not drop below 5 kv when touched by the resistance test contactor, the method for pinpointing the fault is to:

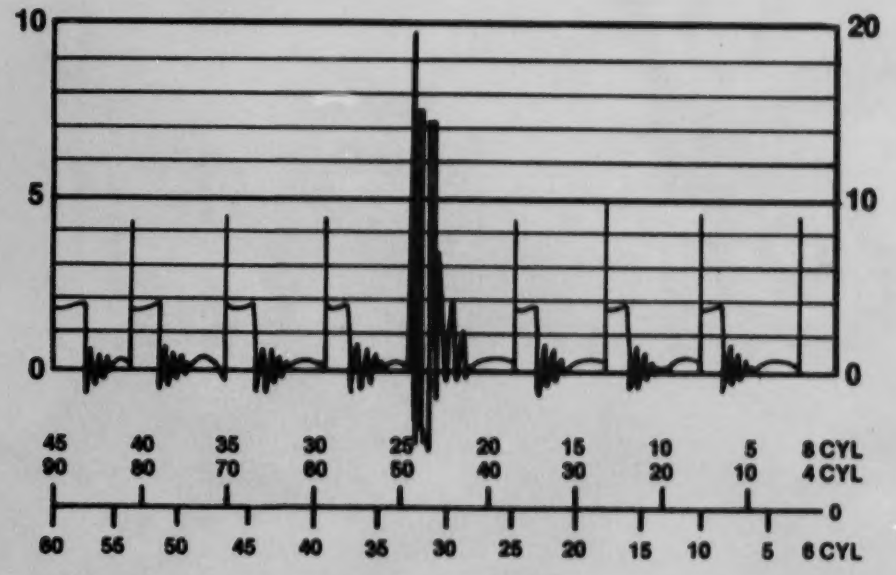
_____ a. substitute a new coil wire
_____ b. substitute a new spark plug wire
_____ c. substitute a new distributor cap
_____ d. substitute a new spark plug

15. A cocked distributor cap would result in a parade pattern that:

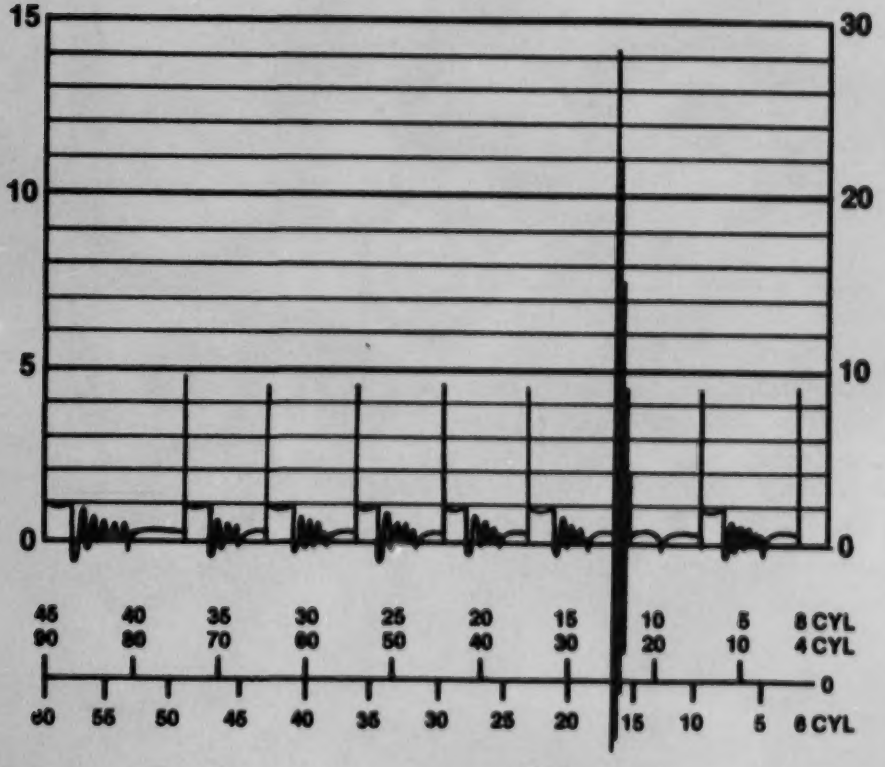
_____ a. has even firing lines
_____ b. has uneven firing lines
_____ c. has all firing lines too high
_____ d. has all firing lines too low

16. Which of the following patterns indicates distributor cap and rotor voltage leakage? (Circle the correct letter(s).)

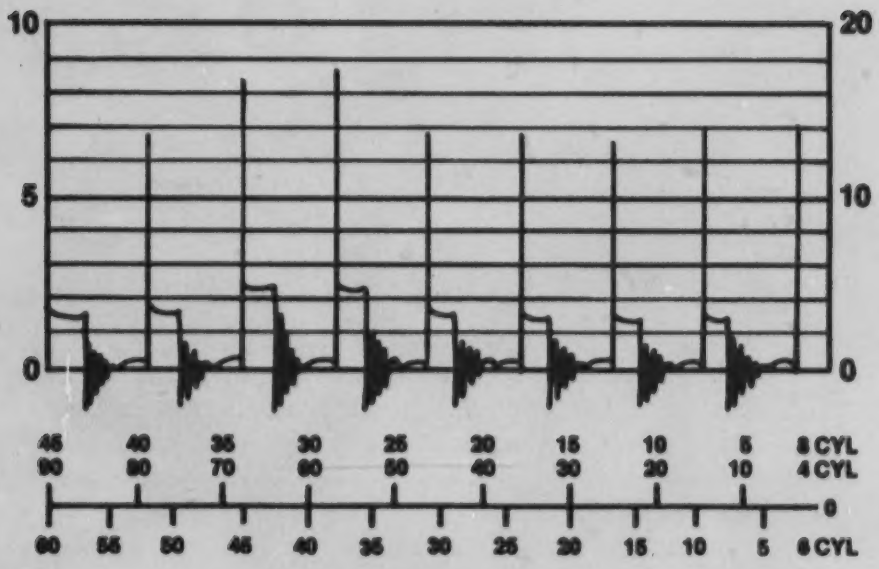
a.



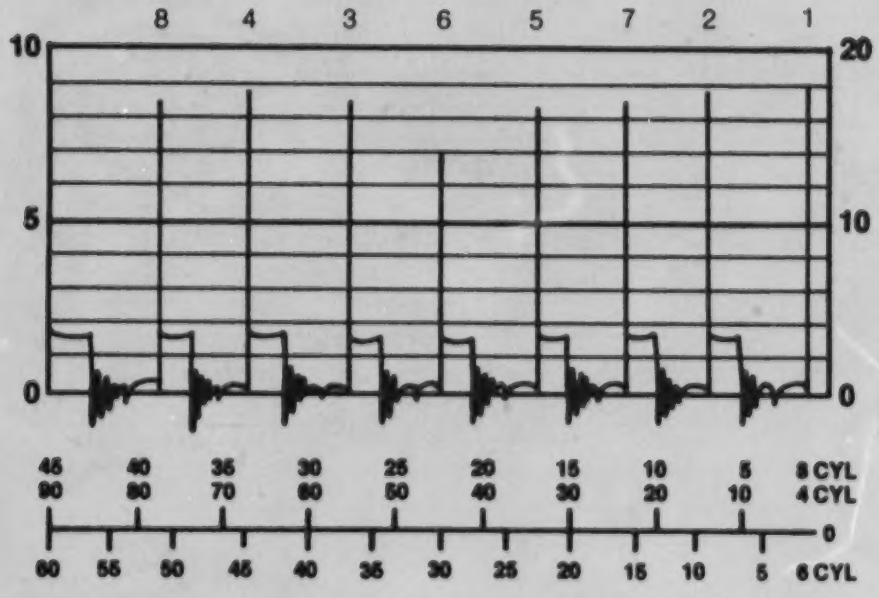
b.



c.


10
5
0
20
10
0
45 40 35 30 25 20 15 10 5 8 CYL
90 80 70 60 50 40 30 20 10 4 CYL
0
60 55 50 45 40 35 30 25 20 15 10 5 6 CYL

d.


8 4 3 6 5 7 2 1
10
5
0
20
10
0
45 40 35 30 25 20 15 10 5 8 CYL
90 80 70 60 50 40 30 20 10 4 CYL
0
60 55 50 45 40 35 30 25 20 15 10 5 6 CYL

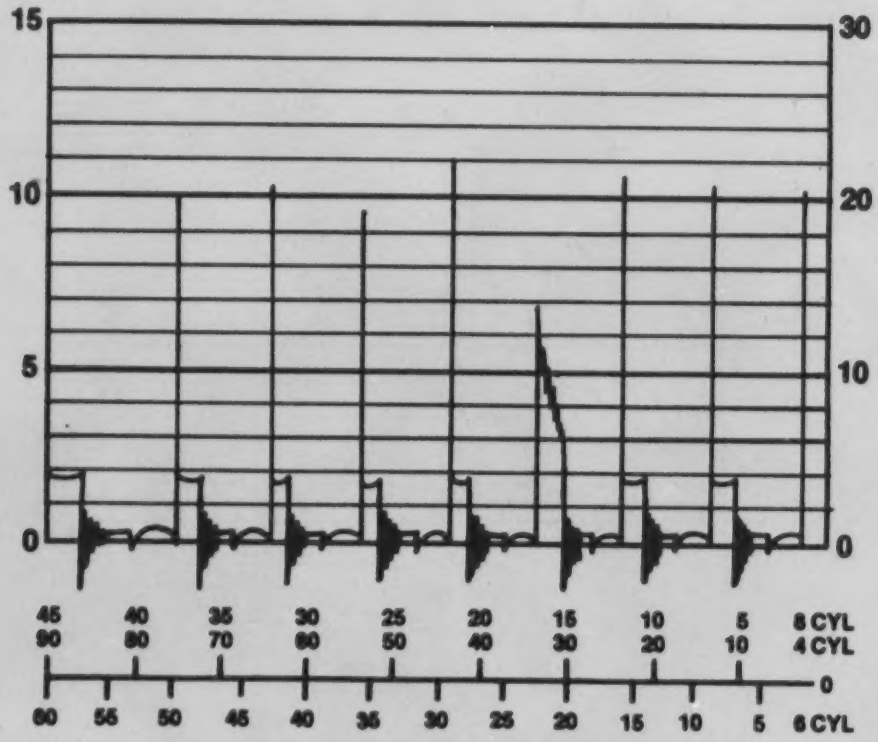
17. In order to measure the voltage required to jump the gap from the rotor to the distributor cap terminals, you need to:

_____ a. ground a distributor terminal segment
_____ b. ground the coil secondary wire
_____ c. ground the spark plug end of a spark plug wire
_____ d. ground the distributor end of a spark plug wire

18. When measuring the distributor cap and rotor air gap, good results for a cylinder would be:

_____ a. a firing line less than 5 kv
_____ b. a firing line less than 8 kv
_____ c. a firing line less than 12 kv
_____ d. a firing line less than 20 kv

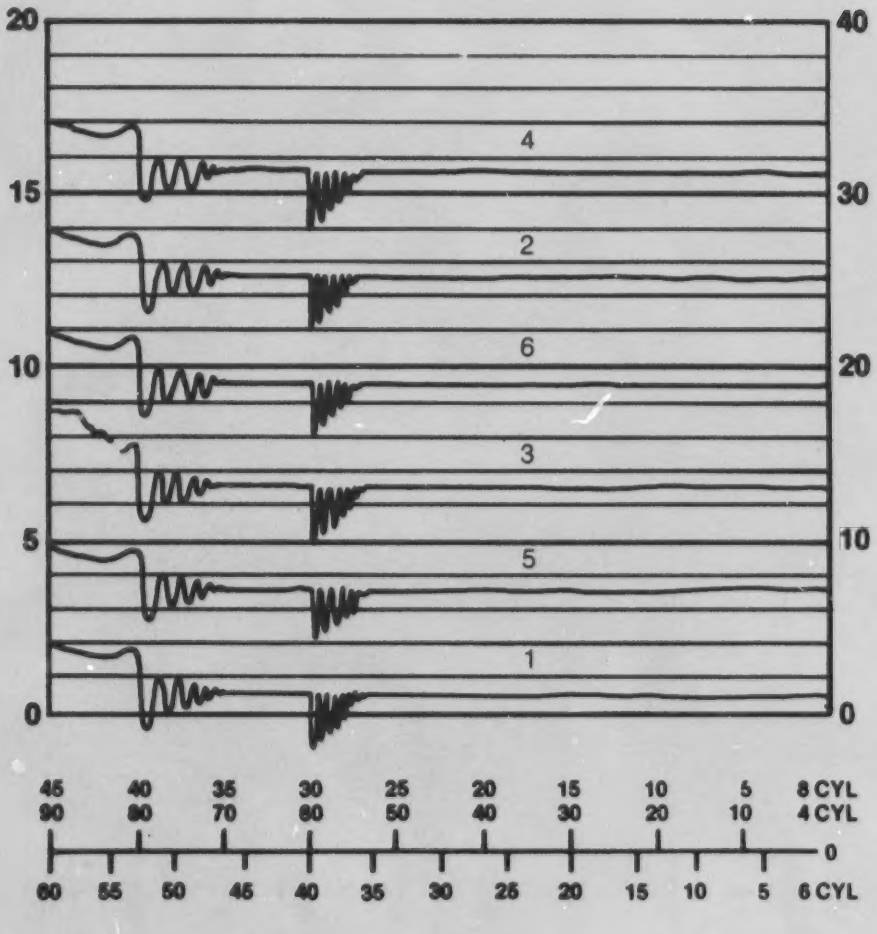
19. Look at the following pattern.



Which of the following conditions would cause this pattern?

_____ a. an oily combustion chamber
_____ b. a defective spark plug wire
_____ c. a cocked distributor cap
_____ d. a blown head gasket
_____ e. normal ignition in all cylinders

20. Look at the following pattern.

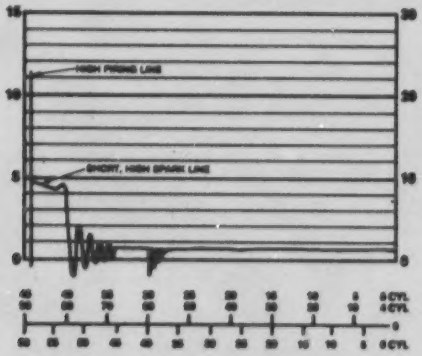


Which of the following conditions could cause this pattern?

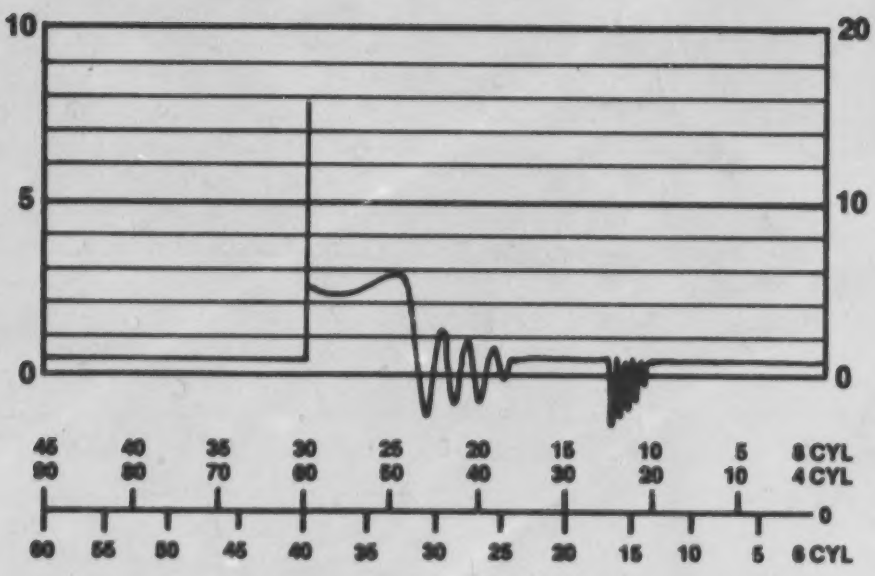
_____ a. a fuel mixture that is too rich
_____ b. a defective coil secondary wire
_____ c. fuel starvation
_____ d. a fouled combustion chamber
_____ e. a leaking exhaust valve

21. Which of the following patterns indicates fuel starvation? (Circle the correct letter.)

a.



b.



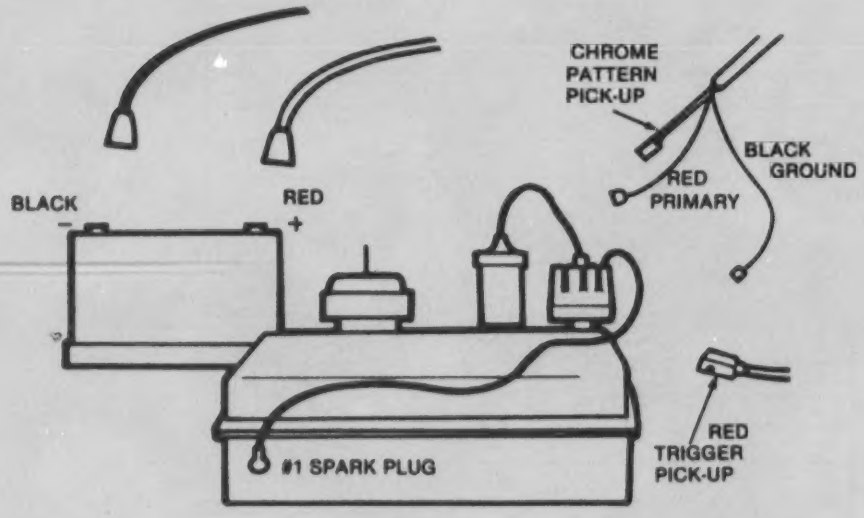
22. If you see a scope pattern that indicates fuel starvation for all cylinders, what should you do?

_____ a. Check carburetor float level.
_____ b. Check carburetor float level and engine timing.
_____ c. Check spark plug wiring and engine timing.
_____ d. Check rotor condition, spark plug wiring, and engine timing.
_____ e. Check engine timing, rotor condition, and carburetor float level.

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 9

1. In the illustration below, draw in the scope test leads and show where they are attached to the vehicle engine.



2. Use the illustration above to identify the connecting points on the engine for the scope test leads.

a. _____

b. _____

c. _____

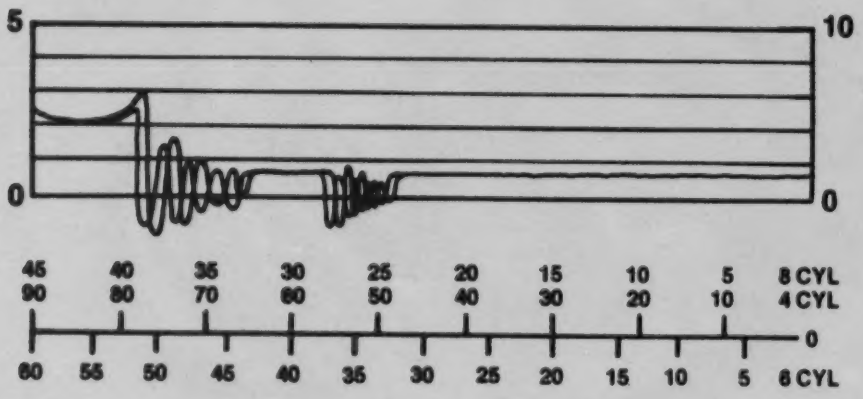
d. _____

e. _____

f. _____

Questions 3-7 below each include a scope pattern and the name of the engine part(s) or condition for which the scope test was made. Check one of the boxes in each question to indicate whether the condition of the part(s) is good or bad.

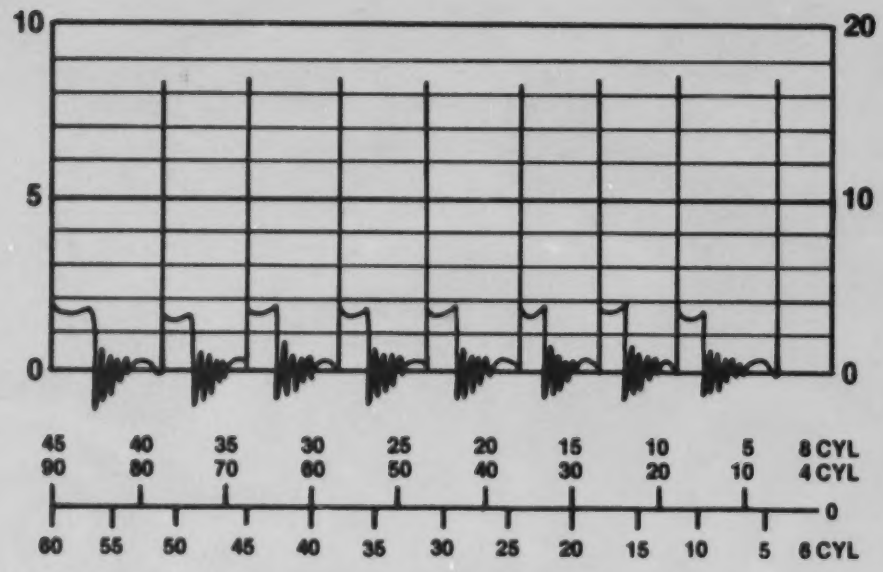
3. Loose secondary coil wire or loose secondary pattern pickup connection



GOOD ☐

BAD ☐

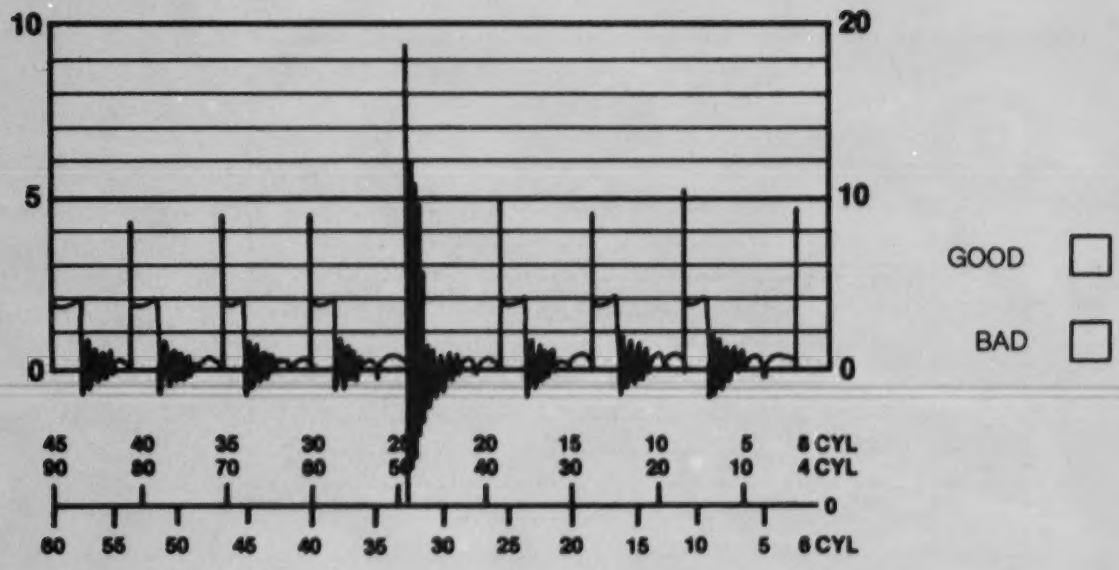
4. Open secondary ignition circuit



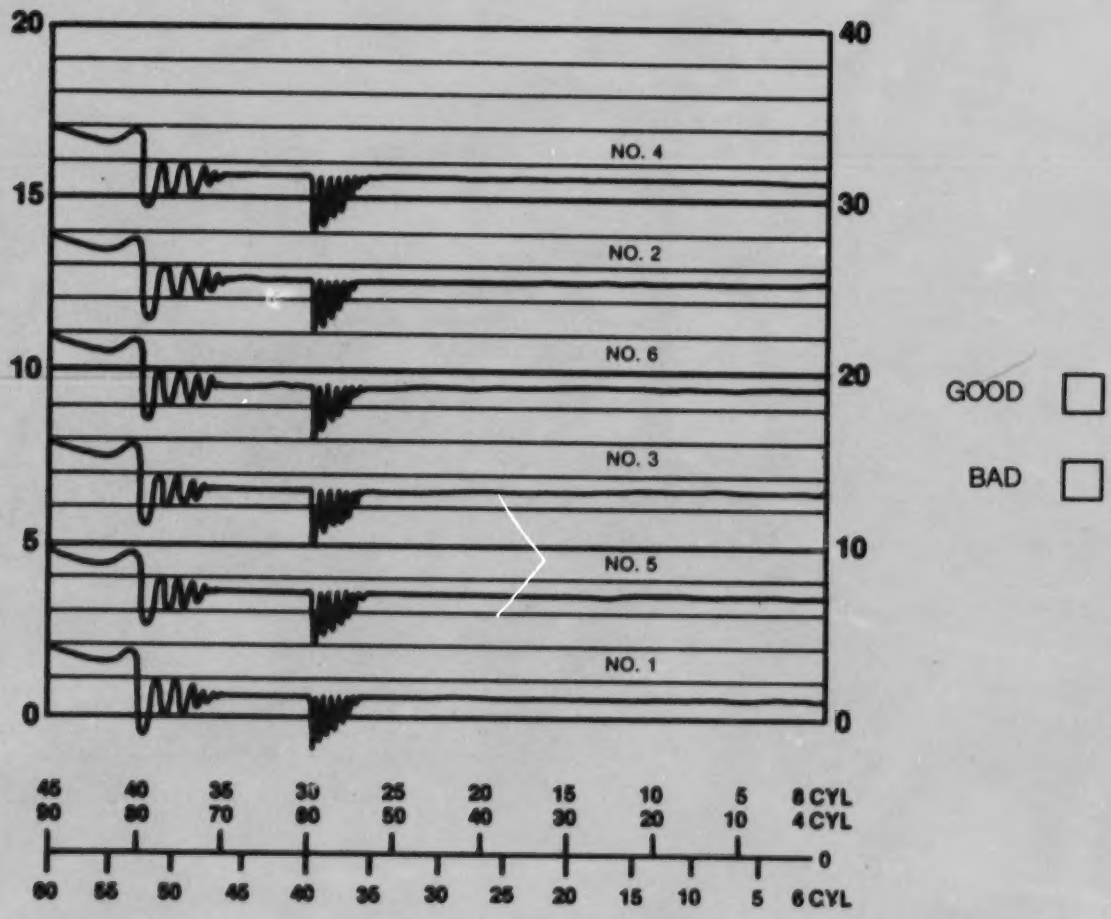
GOOD ☐

BAD ☐

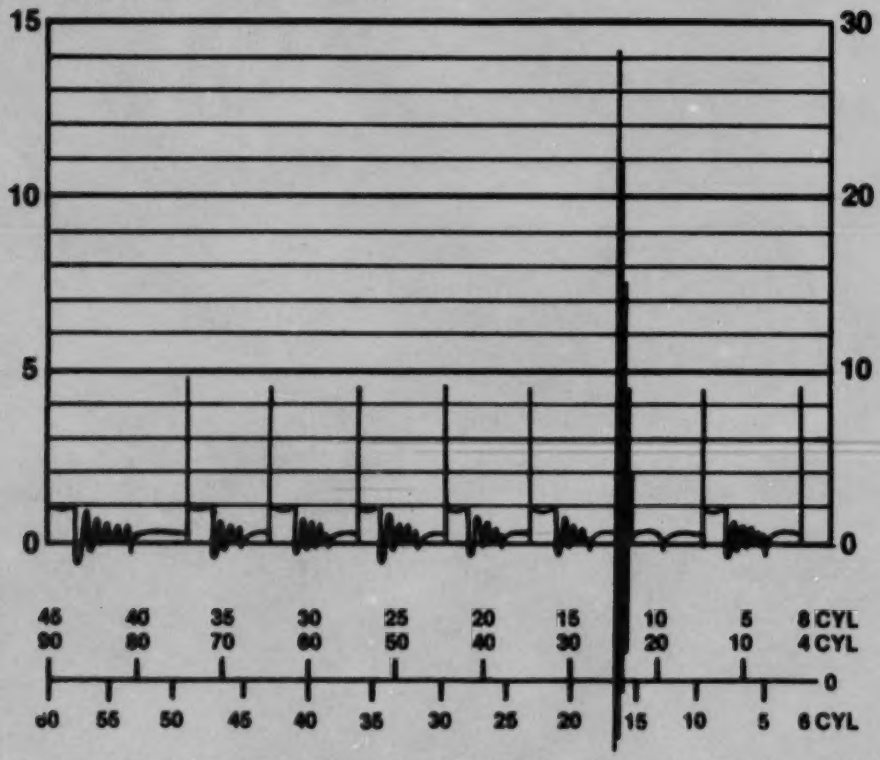
5. Open secondary ignition circuit



6. Secondary ignition circuit condition



7. Available secondary coil voltage test



8. The overall secondary ignition circuit test is performed when the pattern selector is on the _____ pattern.

9. To read secondary ignition scope patterns, you look at the _____ section of the waveform.

10. An open secondary ignition circuit is caused by:

_____ a. a bad spark plug
_____ b. a broken or separated spark plug wire
_____ c. a lean fuel mixture
_____ d. a cocked distributor cap

11. The secondary ignition circuit insulation test is a test of:

_____ a. the distributor cap
_____ b. the rotor
_____ c. the coil wire
_____ d. the spark plug wires
_____ e. all of these

12. To read the secondary ignition circuit insulation test results, you look at:

_____ a. the firing line
_____ b. the spark line
_____ c. the downward part of the firing line
_____ d. the intermediate section

Now turn to the back of this book and check your answers for Exercise 9.

EXERCISE 10

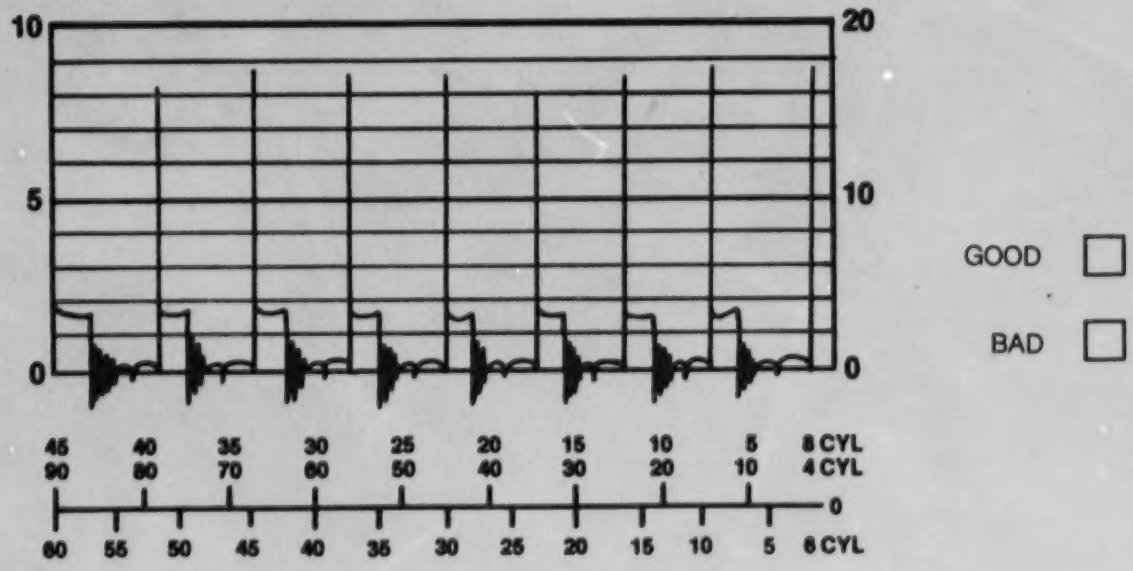
1. Check each correct answer. The spark plug firing voltage scope test analyzes the condition of:

   _____ a. the spark plugs
   _____ b. the secondary circuit
   _____ c. the temperature
   _____ d. the fuel mixture
   _____ e. the cylinder compression pressures
   _____ f. all of these

2. The spark plug firing voltage is the voltage required to fire the spark plugs. (Check one.)

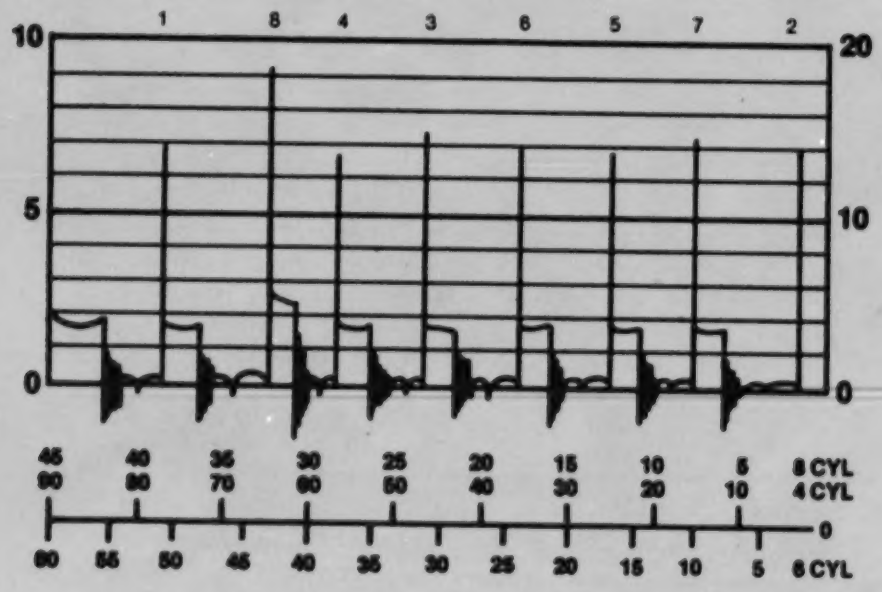
   _____ True
   _____ False

3. The scope pattern below is the result of a spark plug firing voltage test using the 20 kv scale. Check the proper box to indicate whether the voltages are good or bad.



4. The normal height of the firing line should be from _____ to _____, with no more than a _____ variation between cylinders.

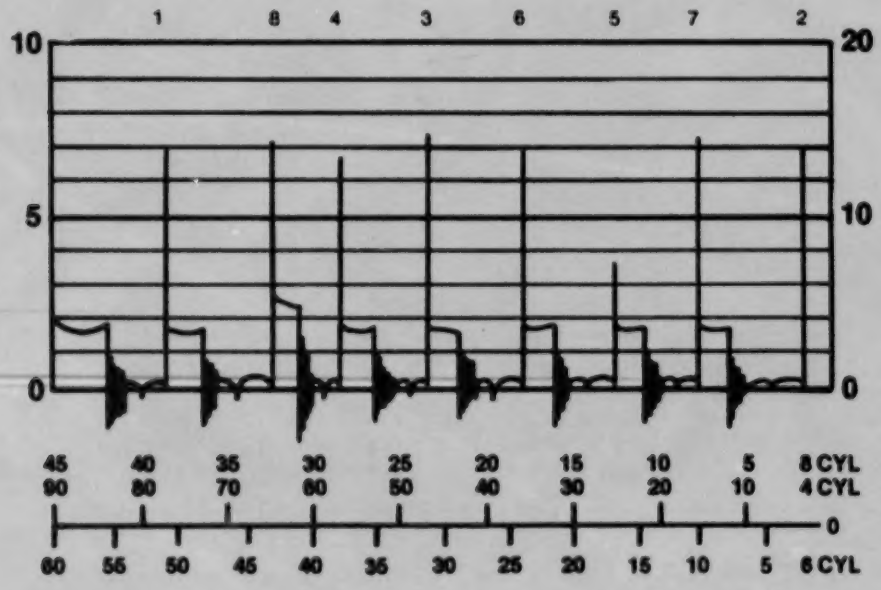
5. The pattern shown in the illustration below shows the spark plug firing voltage (firing order 1-8-4-3-6-5-7-2). The #_____ cylinder has a high firing line.



6. Check each correct answer. In the pattern shown in the illustration above, the high firing line could be caused by:

_____ a. a widely gapped spark plug
_____ b. a worn spark plug
_____ c. a bad spark plug wire
_____ d. a defect in the distributor cap tower
_____ e. all of these

7. The pattern shown in the illustration below shows the spark plug firing voltage (firing order 1-8-4-3-6-5-7-2). The #_____ cylinder has a low firing line.



8. In the pattern shown in the illustration above, the low firing line could be caused by:

_____ a. a fouled spark plug
_____ b. a cracked spark plug insulator
_____ c. spark plug flashover
_____ d. all of these

9. Check each correct answer. When all the firing lines of a display pattern are high, the cause could be:

_____ a. worn or widely gapped spark plugs
_____ b. broken or damaged spark plug wires
_____ c. excessive rotor gap
_____ d. a break in the coil wire
_____ e. late ignition timing
_____ f. a lean fuel mixture

10. Check each correct answer. When all the firing lines of a display pattern are low, the cause could be:

_____ a. fouled spark plugs
_____ b. narrowly gapped spark plugs
_____ c. early ignition timing
_____ d. oil in the cylinders
_____ e. a rich fuel mixture
_____ f. low compression

11. Check each correct answer. When the firing lines of a display pattern are uneven, the cause could be:

_____ a. worn spark plugs
_____ b. breaks in the spark plug wires
_____ c. a worn distributor cap
_____ d. an unbalanced fuel mixture

12. Complete each statement. To specifically locate the cause of either a high or low firing line (spark plug or spark plug wire), you should do the following:

a. Install spark plug _____ between the spark plug and the leads on all abnormal cylinders.

b. Connect a _____ to ground and to the large end of the _____.

c. With the engine operating at _____ RPM, touch the spark plug _____ with the point of the resistance test contactor. Look at the firing line height.

13. If, after you do the procedure in Question 12, the firing line falls below 5 kv, the trouble is in the _____ or the _____.

14. If, after you do the procedure in Question 12, the firing line does not fall below 5 kv, the trouble is in the _____ or the _____.

Now turn to the back of this book and check your answers for Exercise 10.

PERFORMANCE CHECKLIST—P.O. 18

Your instructor will provide either a live vehicle or live engine for this objective. Analyze the engine performance, using an engine analyzer and scope. All necessary tools, equipment, and manuals will be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Hooks up analyzer leads to engine.			
2. Checks for proper engine idle, speed, idle mixture, and dwell; makes necessary adjustments.			
3. Checks over all secondary circuit performance and records any defects.			
4. Checks available coil voltage and secondary circuit insulation, and records results.			
5. Checks spark plug firing voltages and performances, and records results.			
6. Checks distributor cap-to-rotor air gap, and records results.			
7. Checks for these engine-related problems: oily combustion chamber, fouled spark plug, leaking exhaust valve, and fuel starvation; records results.			
8. Makes minor adjustments as necessary.			
9. Uses proper tools and equipment.			
10. Follows all appropriate safety precautions.			
11. Does performance in an acceptable amount of time.			

Keep a copy of this checklist for your records.

PRETEST—P.O. 19: Perform the Cylinder Power Balance Test

Name _____

1. Check (✓) each safety practice listed below that you should follow.
   - _____ a. Rely on memory for making proper test equipment hookups.
   - _____ b. Avoid making electrical tests in or around wet areas.
   - _____ c. Keep pendants or metal jewelry in your pocket.
   - _____ d. Use fender covers only if you are wearing a belt.
   - _____ e. Be sure to route tester leads away from engine fan and fan belt.

2. What does the cylinder power balance test measure?
   - _____ a. firing capacity of each spark plug
   - _____ b. engine RPM drop when a cylinder stops firing
   - _____ c. available spark voltage at each cylinder
   - _____ d. engine compression drop when a cylinder stops firing

3. The steps below for making a cylinder power balance test are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Short out #1 cylinder and record results.
2. _____	b. Repeat process for all cylinders.
3. _____	c. Cancel the shorted cylinder.
4. _____	d. Adjust engine speed to steady idle.
5. _____	e. Set all controls and switches on tester.
6. _____	f. Start and warm up engine.
7. _____	g. Hook up tester.

4. Normal RPM loss for a 4-cylinder engine in a cylinder balance test is:
   - _____ a. less than an 8-cylinder engine
   - _____ b. less than a 6-cylinder engine
   - _____ c. more than a 6-cylinder engine

5. Look at the following results of a cylinder balance test on a 6-cylinder engine.

	CYLINDER NO.					
850 RPM IDLE:	1	2	3	4	5	6
low RPM	750	760	790	740	750	760

These results indicate that:
   - _____ a. RPM drop is much too low for this engine
   - _____ b. equal power output is coming from the cylinders
   - _____ c. cylinder #3 very likely has some defect
   - _____ d. cylinder #4 very likely has some defect
   - _____ e. overall, RPM drop is much too high for this engine

6. When making a cylinder balance test on late-model vehicles, you may have to:

_____ a. disconnect and plug the line to the EGR valve
_____ b. disconnect and plug the PCV valve line
_____ c. disconnect and plug the air injection line
_____ d. disconnect and plug the vacuum advance line

7. If the engine shows no RPM drop from one or more cylinders in a power balance test, and the spark plug firing voltage is low for that cylinder, you would:

_____ a. suspect a defective spark plug wire
_____ b. check for vacuum leaks
_____ c. suspect a bad cylinder
_____ d. suspect a blown head gasket

8. The symptoms of a bad distributor cap are:

_____ a. all cylinders are low on same intake manifold passageway, and spark firing voltage is high
_____ b. one or more cylinders are low and spark firing voltage is high
_____ c. one or more cylinders are dead and spark firing voltage is high
_____ d. adjacent cylinders dead and spark firing voltage is low

9. Symptoms of a blown head gasket would be:

_____ a. all cylinders are low and spark firing voltage is high
_____ b. adjacent cylinders are low and spark firing voltage is high
_____ c. one or more cylinders are low and spark firing voltage is high
_____ d. one or more cylinders are dead and spark firing voltage is high

10. The best action to take if a cylinder balance test showed that one or more cylinders were low and spark firing voltages were high would be to:

_____ a. check for vacuum leaks
_____ b. check spark timing
_____ c. check engine compression
_____ d. check secondary wiring

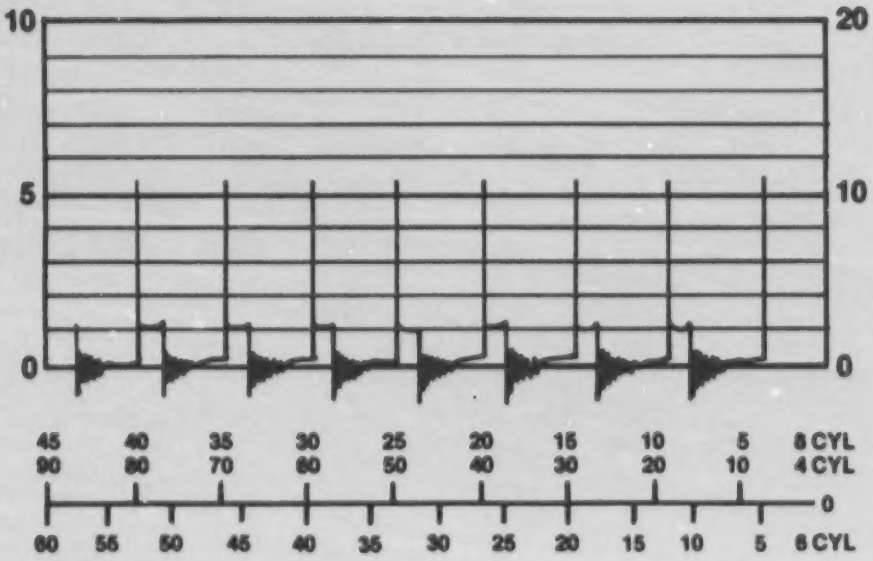
When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 11

1. Distributor cap and rotor problems are found by using a scope to observe the _____ _____ of the display pattern.

Questions 2 and 3 below each include a scope test pattern and the name of an engine part or condition for which the scope test was made. Indicate the condition of the part by checking the proper box.

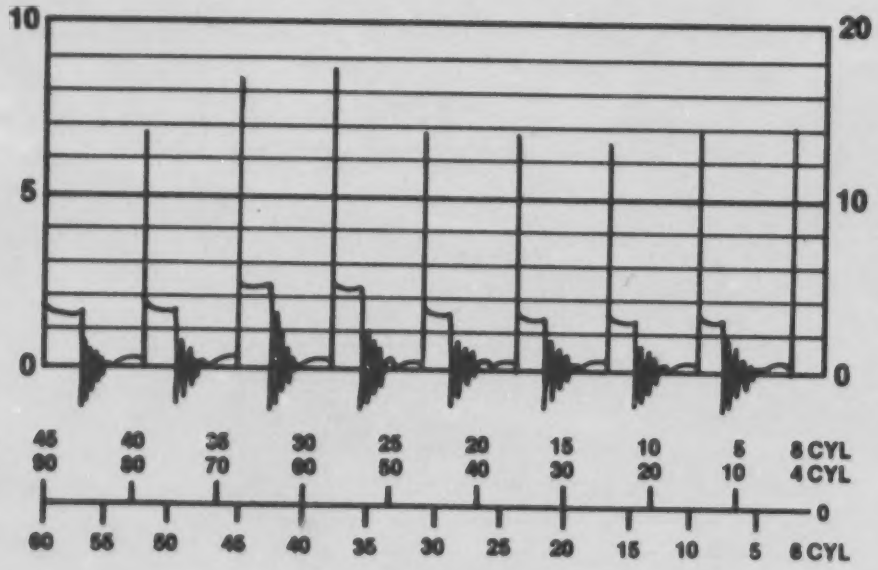
2. Firing lines



GOOD ☐

BAD ☐

3. Cocked distributor cap

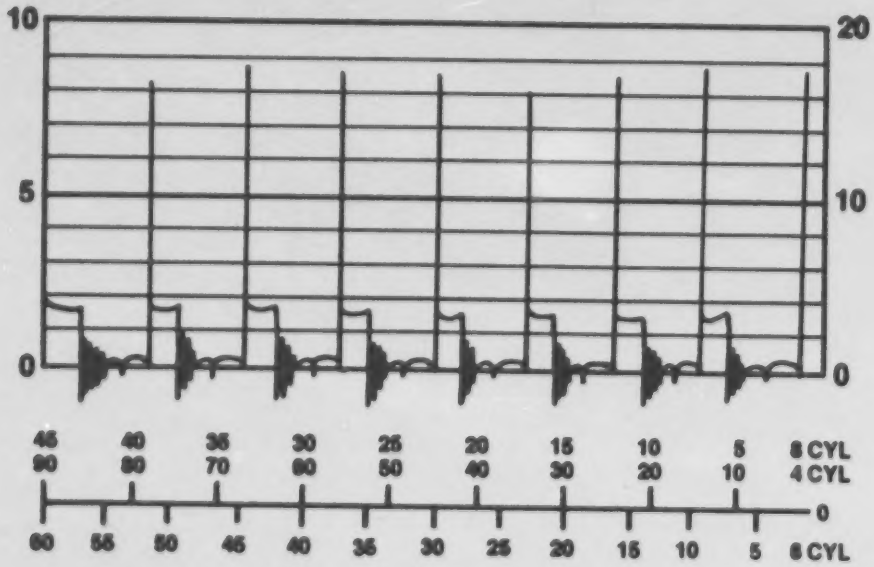


YES ☐

NO ☐

4. To do a distributor cap and rotor leakage test, operate the engine at _____ RPM and disconnect a spark plug wire from the _____.

5. On the illustration below, draw an example of the scope pattern that indicates a secondary leakage between the rotor and the distributor cap segment.



6. To do a distributor cap and rotor air gap test, clip one end of a jump wire to _____ and touch the probe end to the _____.
7. The distributor cap and rotor air gap is normal when the firing line measures less than _____.
8. Replace the distributor cap and rotor if the firing line measures more than _____.

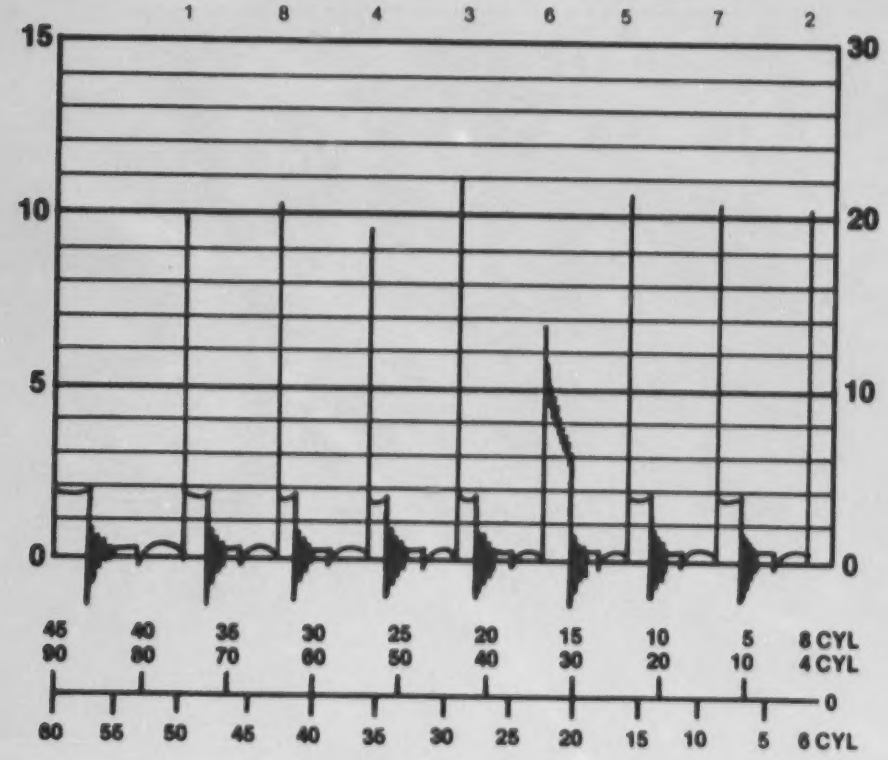
Now turn to the back of this book and check your answers for Exercise 11.

EXERCISE 12

1. Some engine/ignition-related problems are found with the scope by observing the _____ section of the waveform.
2. The bad scope pattern in the illustration below indicates:
   a. _____

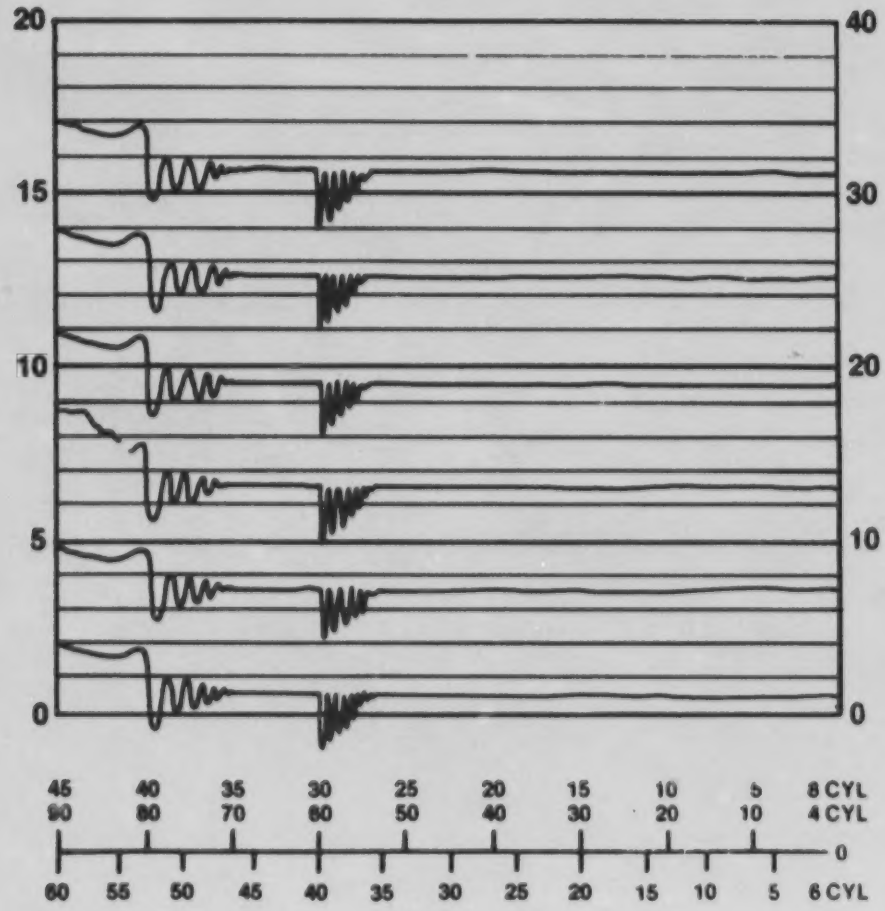
   OR

   b. _____



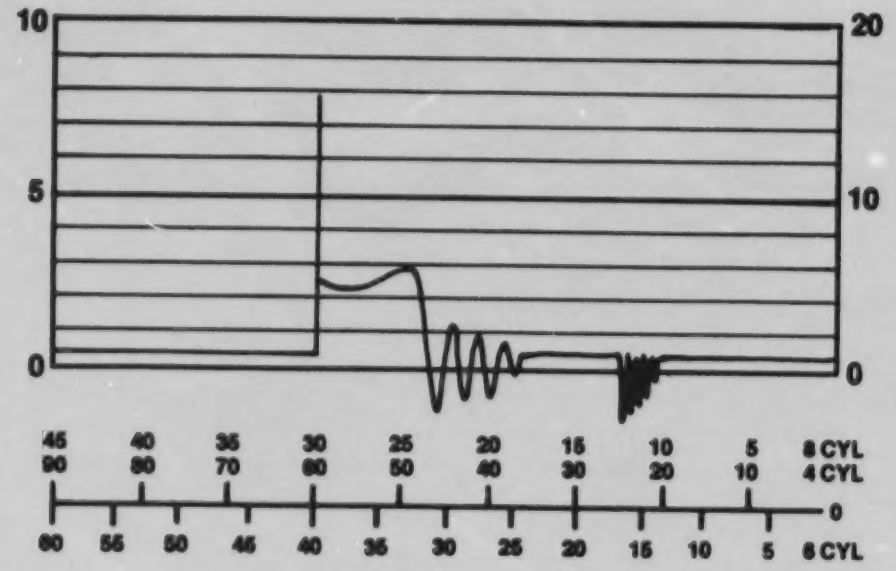
3. In the illustration above, the cylinder having the bad firing line is cylinder # _____ (engine firing order is 1-8-4-3-6-5-7-2).

4. The bad spark line on the raster pattern illustrated below indicates a _____.



5. In the illustration above, the cylinder having the bad spark line is cylinder # _____ (engine firing order is 1-5-3-6-2-4).

6. The bad spark line illustrated below indicates _____ or _____.



Now turn to the back of this book and check your answers for Exercise 12.

EXERCISE 13

1. The cylinder power balance test tests the power _____ of each cylinder.
2. The cylinder power balance test checks whether all cylinders are producing _____ power.
3. To do a cylinder power balance test, you use a/an _____.
4. To do a cylinder power balance test, the engine must be at operating _____.
5. To do a cylinder power balance test, you must first set up the engine analyzer as follows:
   STEP 1 _____
   _____
   STEP 2 _____
   _____
   STEP 3 _____
   _____
   STEP 4 _____
   _____
   STEP 5 _____
   _____
   STEP 6 _____
   _____
6. To then do the test, you:
   STEP 7 _____
   STEP 8 _____
   STEP 9 _____
   STEP 10 _____
7. After shorting out a spark plug and reading the results, you must push the _____ button to return the cylinder to _____ before you short out the next cylinder.
8. When reading cylinder power balance test results, you should look for excessive _____ between cylinders.
9. Test results are good when the difference is less than _____ RPM between cylinders.
10. Test results are good when the difference is less than _____ percent in the readings between cylinders.

Now turn to the back of this book and check your answers for Exercise 13.

EXERCISE 14

1. Generally, when one or more cylinders show variation readings beyond the recommended limits, you should check the _____ condition of the engine.
2. When the scope is attached, it is possible to test _____ problems at the same time that the cylinder power balance test is done.
3. A cylinder power balance test shows one cylinder "dead" and a scope reading _____ 5 kv. The problem is a bad _____ or a _____.
4. A cylinder power balance test shows one cylinder to be low and a high scope reading. The problem is a _____.
5. A cylinder power balance test shows two adjacent cylinders as being dead or low. The problem is possibly a _____.
6. A cylinder power balance test, done with a scope attached, shows one or more cylinders to be dead and a high-kv firing line. The problem is a bad _____.
7. A cylinder power balance test, done with a scope attached, shows one or more cylinders to be dead and a low-kv firing line. The problem is a bad _____ or _____.
8. A cylinder power balance test, done with a scope attached, shows one or more cylinders to be low and a low-kv firing line. The problem is a bad _____.
9. If electrical conditions are corrected, but a cylinder power balance test still shows that one or more cylinders are dead or low, you should do a _____ _____ test.

Now turn to the back of this book and check your answers for Exercise 14.

PERFORMANCE CHECKLIST—P.O. 19

Your instructor will provide either a live vehicle or live engine for this objective. Perform a cylinder power balance test on an engine. All necessary tools, equipment, and manuals will be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Hooks up cylinder-balance test equipment to engine.			
2. Adjusts engine idle to recommended speed.			
3. Performs the cylinder balance test, and records results.			
4. Interprets results, naming cylinder(s) at fault.			
5. Uses proper tools and equipment.			
6. Follows all appropriate safety precautions.			
7. Does performance in an acceptable amount of time.			

Keep a copy of this checklist for your records.

PRETEST—P.O. 20: Perform a Cylinder Leakage Test

Name _____

1. Check (✓) each safety practice listed below that you should follow.
   _____ a. Follow correct procedures when removing and installing spark plugs.
   _____ b. Wear clothing that is very loose for ease of movement.
   _____ c. Follow test equipment manufacturer's instructions.
   _____ d. Use a fender cover when working under the hood.
   _____ e. Always follow safety precautions when using compressed air.

2. Normally, you would perform a cylinder leakage test when:
   _____ a. a cylinder balance test has shown poor results
   _____ b. a compression test has shown good results
   _____ c. a customer complains about loss of engine power
   _____ d. the spark timing has been altered

3. When you make a cylinder leakage test, you should make sure that:
   _____ a. the piston is at TDC
   _____ b. the timing marks are lined up
   _____ c. the piston is at BDC
   _____ d. the distributor rotor points 180 degrees away from the cylinder being tested

4. The first two steps in making a cylinder leakage test are the following:
   _____ a. Hook up remote starter switch and warm up engine.
   _____ b. Warm up engine and remove all spark plugs.
   _____ c. Remove all spark plugs and hook up leakage tester.
   _____ d. Remove radiator cap and air cleaner, and connect remote starter switch.

5. For a cylinder leakage test, one way to tell if the piston is in the proper location is to stop cranking the engine when:
   _____ a. the whistle just stops sounding
   _____ b. the whistle just starts sounding

6. The steps below for making a cylinder leakage test are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Remove radiator cap, oil filler cap, and carburetor air filter.
2. _____	b. Attach indicator light, and connect cylinder leakage tester to hose.
3. _____	c. Remove distributor cap, install TDC indicator, and mark reference point on engine.
4. _____	
5. _____	d. Read percent of cylinder leakage.
6. _____	e. Remove all spark plugs.
7. _____	f. Connect remote start switch.
	g. Crank engine for proper piston location.

7. For a cylinder leakage test, results are considered good if:

_____ a. leakage is less than 20 percent and no audible air leaks are detected
_____ b. leakage is more than 20 percent and no audible air leaks are detected
_____ c. leakage is more than 20 percent and audible air leaks are detected
_____ d. leakage is less than 20 percent and audible air leaks are detected

8. In a cylinder leakage test, the most likely cause of air escaping from the carburetor is:

_____ a. bad piston rings
_____ b. cracked head
_____ c. defective intake valve
_____ d. defective exhaust valve

9. In a cylinder leakage test, the most likely cause of air escaping from an adjacent cylinder is:

_____ a. defective intake valve
_____ b. defective exhaust valve
_____ c. bad piston rings
_____ d. cracked head

10. When making a cylinder leakage test on a 4-cylinder engine, after testing the number one cylinder you should test the remaining cylinders:

_____ a. in *reverse* numerical order (1-4-3-2)
_____ b. in *reverse* firing order (1-2-4-3)
_____ c. in numerical order (1-2-3-4)
_____ d. in firing order (1-3-4-2)

11. The steps below for testing other cylinders in a cylinder leakage test are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Reinstall all removed parts and attach all removed wires.
2. _____	b. Remove remote start switch.
3. _____	c. Remove adapter and hose from last cylinder tested.
4. _____	d. Disconnect tester hose from adapter and crank engine until TDC indicator aligns with mark and indicator light glows.
5. _____	e. Install adapter in next cylinder and read test results.
6. _____	f. Repeat steps for other cylinders.

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 15

1. The cylinder leakage test is used after you get poor test results from the _____ _____ _____ test.
2. The cylinder leakage tester tests the _____ condition of the engine.
3. The cylinder leakage tester can locate _____ losses in an engine.
4. List the faulty engine parts that a cylinder leakage test can uncover.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

For questions 5-9, write *T* in the blank if the statement is true, and *F* if the statement is false.

5. _____ The cylinder leakage test will tell which engine part is at fault.
6. _____ When you use the tester, the piston must be at TDC.
7. _____ Air under pressure is forced into the cylinder when the piston is at TDC.
8. _____ No excessive air should escape from a good cylinder.
9. _____ The engine must be at normal operating temperatures before you perform a cylinder leakage test.
10. To perform a cylinder leakage test for one cylinder, you first set up the cylinder leakage tester as follows:

    STEP 1 _____
    _____
    STEP 2 _____
    _____
    STEP 3 _____
    _____
    STEP 4 _____
    _____
    STEP 5 _____
    _____
    STEP 6 _____
    _____

11. To then do the test, you:

STEP 1 _____

_____

STEP 2 _____

_____

STEP 3 _____

_____

12. The cylinder leakage test results are good when the gauge reads less than _____.

13. Air escaping from the cylinders next to the one being tested indicates:

_____ a. a bad intake valve
_____ b. bad piston rings
_____ c. a blown head gasket
_____ d. a bad exhaust valve

14. Air escaping from the carburetor indicates:

_____ a. a bad intake valve
_____ b. bad piston rings
_____ c. a blown head gasket
_____ d. a bad exhaust valve

15. Air escaping from the tail pipe indicates:

_____ a. a bad intake valve
_____ b. bad piston rings
_____ c. a blown head gasket
_____ d. a bad exhaust valve

16. Air escaping from the oil filler indicates:

_____ a. a bad intake valve
_____ b. bad piston rings
_____ c. a bad head gasket
_____ d. a bad exhaust valve

Now turn to the back of this book and check your answers for Exercise 15.

PERFORMANCE CHECKLIST—P.O. 20

Your instructor will provide either a live vehicle or live engine for this objective. Perform a cylinder leakage test on the engine. All necessary tools, equipment, and manuals will be made available.

Student Performances

1. Removes spark plugs, air cleaner, crankcase oil filler cap, and radiator cap.
2. Sets carburetor throttle valve in wide-open position.
3. Disables ignition system.
4. Uses remote starter switch and whistle to set #1 cylinder to TDC.
5. Installs TDC indicator, makes reference mark, and attaches indicator light.
6. Connects leakage tester and records results; listens for escaping air.
7. Repeats test for all cylinders.
8. Interprets results, noting faulty cylinder(s).
9. Removes test equipment, installs all removed parts, and attaches all wires.
10. Uses proper tools and equipment.
11. Follows appropriate safety precautions.
12. Does performance in an acceptable amount of time.

Keep a copy of this checklist for your records.

Instructor Ratings

Acceptable		Not Acceptable		Omit

PRETEST—P.O. 21: Perform a Cylinder Compression Test

Name _____

1. Check (✓) each safety practice listed below that you should follow:
   - _____ a. Avoid wearing metal jewelry.
   - _____ b. Use the correct tools when removing spark plugs.
   - _____ c. Avoid wearing loose clothing.
   - _____ d. Use fender covers only if you are wearing a belt.
   - _____ e. Always wear eye protection when working with compressed air.
   - _____ f. Rely on memory for proper method when using test equipment.

2. The compression test is normally performed when:
   - _____ a. the results of a cylinder leakage test are good
   - _____ b. the results of a cylinder leakage test are bad
   - _____ c. the results of a cylinder power balance test are good
   - _____ d. the results of a cylinder power balance test are bad

3. The steps below for checking cylinder compression are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Disable the ignition.
2. _____	b. Insert compression tester in spark plug hole.
3. _____	c. Remove carburetor air cleaner and block throttle valve wide open.
4. _____	d. Crank engine four to five strokes and note reading.
5. _____	e. Connect remote starter switch.
6. _____	f. Remove all spark plugs.

4. As a general rule, compression test results are good if:
   - _____ a. no cylinder has a reading of less than 180 psi
   - _____ b. there is no more than 10 psi variation between all cylinders
   - _____ c. the lowest-reading cylinder reads at least 75 percent as high as the highest-reading cylinder
   - _____ d. there is no more than a 15 percent difference between the highest- and lowest-reading cylinders

5. Which of the following sets of readings would indicate poorest engine performance if manufacturer specifies 185 psi? (Check one.)

_____ a.

Cylinder	1	2	3	4	5	6
Compression	190	185	170	145	180	185

_____ b.

Cylinder	1	2	3	4	5	6
Compression	145	140	145	145	140	145

_____ c.

Cylinder	1	2	3	4	5	6
Compression	170	165	170	170	165	165

6. If one or more cylinders read low during a cylinder compression test, you should:

_____ a. squirt oil into the high-reading cylinders and then recheck compression
_____ b. squirt oil into the low-reading cylinders and then recheck compression
_____ c. recheck the compression of the low-reading cylinders

7. If the overall results of a compression test are higher than normal, the problem is:

_____ a. worn or defective piston rings
_____ b. excessive carbon buildup
_____ c. burned valves
_____ d. cracked engine block
_____ e. blown head gasket

8. If the cylinder compression tests show an increase in compression in low-reading cylinders when oil is added, the problem is very likely:

_____ a. worn or defective piston rings
_____ b. burned valves
_____ c. blown head gasket
_____ d. excessive carbon buildup
_____ e. warped cylinder head

9. If both the dry and wet compression test results show low readings on side-by-side cylinders, a likely problem is:

_____ a. excessive carbon buildup
_____ b. a blown head gasket
_____ c. defects in the valve train
_____ d. worn or defective piston rings

10. Check each correct answer. After making the cylinder compression tests, you should:

_____ a. reinstall the air cleaner
_____ b. clean, file, and regap spark plugs as necessary
_____ c. block carburetor choke
_____ d. turn ignition off
_____ e. reinstall spark plugs
_____ f. remove remote starter switch

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 16

1. The compression test is made following poor test results from the _____ _____ _____ test.
2. The compression tester tests the _____ condition of the engine.
3. The compression tester can locate _____ losses in an engine.
4. List the faulty engine parts that a compression test can uncover.
   a. _____
   b. _____
   c. _____

For questions 5 - 9, write *T* in the blank if the statement is true, and *F* if the statement is false.

5. _____ The engine must be at normal operating temperatures before you do a compression test.
6. _____ The compression test will tell which major parts in the cylinder are at fault.
7. _____ Compression readings are given in pounds per square inch (psi).
8. _____ To obtain true compression readings, the engine must be cranked for four or five compression strokes.
9. _____ Only the highest compression reading of a cylinder is written down.
10. To do a compression test on an engine, you follow these step-by-step procedures.
    STEP 1 _____
    _____
    STEP 2 _____
    _____
    STEP 3 _____
    _____
    STEP 4 _____
    _____
    STEP 5 _____
    _____
    STEP 6 _____
    _____
    STEP 7 _____
    _____
11. Compression pressures are considered to be normal if the lowest cylinder reading is more than _____ of the highest cylinder reading.
12. Variations in readings between cylinders will have _____ effect on engine performance than will overall readings that are even or slightly low.

13. Oil was squirted into a cylinder having a low compression reading. When the compression was retested, the reading increased. This indicates:

_____ a. bad valves
_____ b. a blown head gasket
_____ c. bad rings
_____ d. carbon buildup

14. When the cylinder in Question 13 was retested, the reading did not increase. This indicates:

_____ a. bad rings
_____ b. bad valves
_____ c. a blown head gasket
_____ d. a cracked block
_____ e. a bad piston

15. When two side-by-side cylinders with low compression ratings were retested, the readings did not increase. This indicates:

_____ a. a bad piston
_____ b. bad valves
_____ c. a blown head gasket
_____ d. cylinder carbon buildup

Now turn to the back of this book and check your answers for Exercise 16.

PERFORMANCE CHECKLIST—P.O. 21

Your instructor will provide either a live vehicle or live engine for this objective. Perform a cylinder compression test on an engine. All necessary tools, equipment, and manuals will be made available.

Student Performances

1. Removes all spark plugs.
2. Removes air cleaner and sets the carburetor throttle in wide-open position.
3. Disables the ignition.
4. Attaches the remote starter switch.
5. Inserts compression gauge and cranks engine four or five times; records results.
6. Repeat Performance 5 (above) for all cylinders.
7. Performs wet compression test(s) as necessary.
8. Interprets results, noting defective cylinder(s).
9. Removes test equipment, installs all removed parts, and unblocks the throttle.
10. Uses correct tools and equipment.
11. Follows appropriate safety precautions.
12. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable		Not Acceptable		Omit

Keep a copy of this checklist for your records.

PRETEST—P.O. 22: Test and Repair Transistor Ignition System

Name _____

PART I: GENERAL

1. Check (✓) each safety practice listed below that you should follow:
   _____ a. Avoid reaching without looking.
   _____ b. Wear very loose clothing for ease of movement.
   _____ c. Follow correct procedures for removing spark plug wires.
   _____ d. Always follow test equipment manufacturer's instructions.
   _____ e. Wipe distributor cap and area clean after removing the cap.
   _____ f. Avoid wearing metal jewelry when working around an automobile.

2. Which of the following units serves to replace the contact breaker points in the Ford, Chrysler, and GM electronic ignitions?
   _____ a. ballast wire
   _____ b. electronic control module
   _____ c. magnetic signal assembly
   _____ d. high-energy coil
   _____ e. wiring harness connectors

3. In the Ford, Chrysler, and GM electronic ignition systems, which component actually switches primary current on and off through the coil?
   _____ a. reluctor
   _____ b. armature
   _____ c. electronic control module
   _____ d. magnetic signal assembly
   _____ e. pickup coil unit

4. Which of the following is NOT an advantage of the transistor ignition system?
   _____ a. fewer scheduled tune-ups
   _____ b. reduced secondary voltages
   _____ c. extended spark plug life
   _____ d. reduced vehicle emissions
   _____ e. reduced distributor servicing

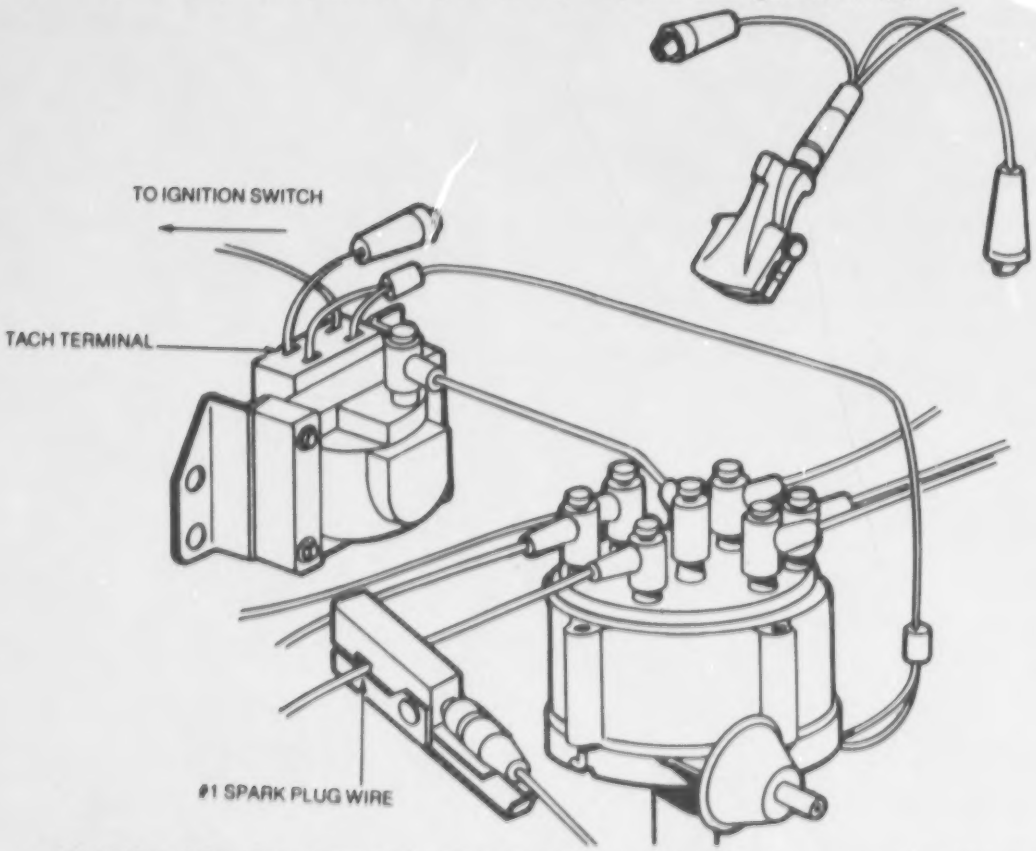
5. Check (✓) each part of a conventional ignition system that is eliminated in a transistor ignition system.

_____ a. condenser
_____ b. secondary wires
_____ c. mechanical advance unit
_____ d. vacuum advance unit
_____ e. coil
_____ f. spark plugs
_____ g. rubbing block
_____ h. distributor
_____ i. rotor
_____ j. contact points

6. Which make of automobile with a transistor ignition requires special adaptors in order to hook up an oscilloscope?

_____ a. GM
_____ b. Ford
_____ c. Chrysler

7. Draw the proper hookup for an oscilloscope to a GM L6 engine with HEI.



Adapted from *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions*. Used with permission of Sun Electric Corporation.

8. Which of the following facts about a secondary scope pattern for an electronic ignition-equipped Chrysler is true?

_____ a. The firing line voltage is between 15 and 17 kv.
_____ b. There is an unusual "lump" in the dwell section.
_____ c. The dwell section of the waveform is curved and longer than normal.
_____ d. The waveform does not have a dwell section.

9. Which of the following facts about a secondary scope pattern for a solid-state ignition-equipped Ford is true?

_____ a. The firing lines are spaced closer together than normal.
_____ b. There is an unusual "lump" in the dwell section.
_____ c. The waveform has no dwell section.
_____ d. The firing line and firing time are the same.

10. Which of the following facts about a secondary scope pattern for a high-energy ignition-equipped GM vehicle is true?

_____ a. The waveform does not have a dwell section.
_____ b. The dwell section of the waveform is curved and longer than normal.
_____ c. The waveform has an unusual "lump" in the dwell section.
_____ d. The firing line and spark line are the same.

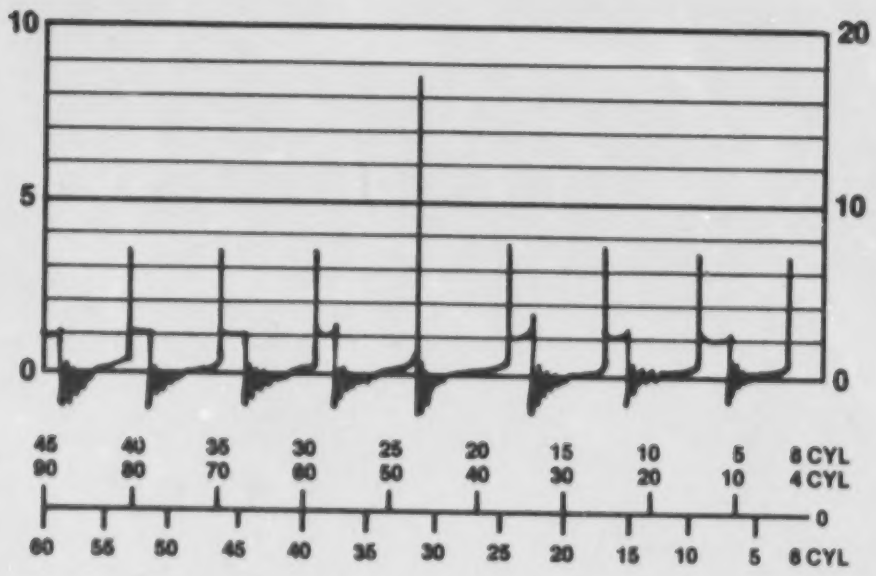
11. Check (✓) the conditions listed below that indicate a possible malfunction in a transistor ignition system.

_____ a. engine misses
_____ b. engine knocks
_____ c. vehicle exhaust emissions decrease
_____ d. engine surges severely
_____ e. engine will not start

12. The available voltage test on transistor ignition-equipped vehicles is performed by:

_____ a. removing a spark plug wire and holding it to ground
_____ b. removing coil secondary wire and holding it to ground
_____ c. removing a spark plug wire and holding it away from ground
_____ d. removing coil secondary wire and holding it away from ground

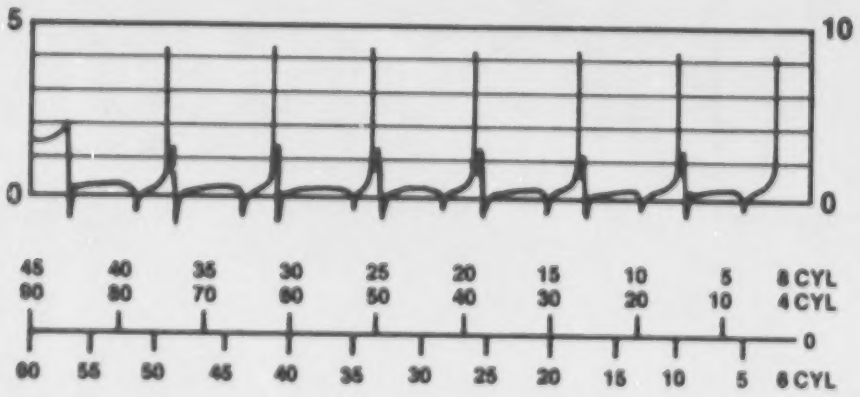
13. Look at the following pattern from an available voltage test.



This waveform indicates that:

_____ a. there is a problem in the transistor ignition system
_____ b. there is no problem in the transistor ignition system

14. Look at the following pattern from a spark plug voltage test.



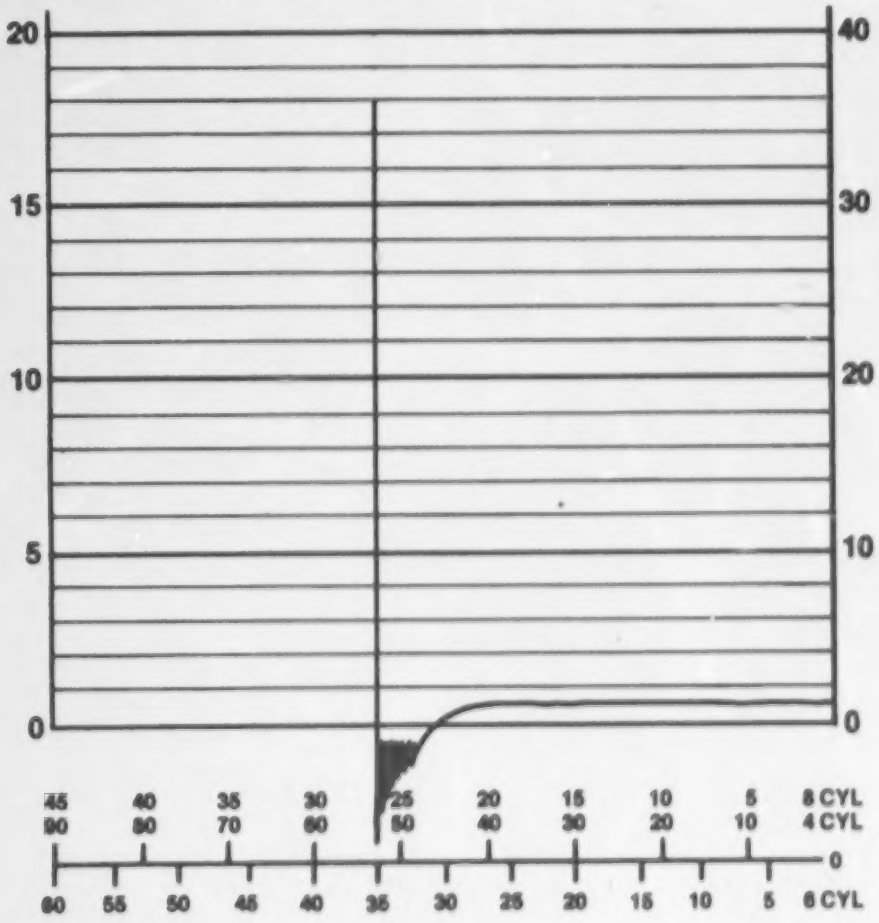
This pattern indicates that:

_____ a. there is a problem in the transistor ignition system
_____ b. some spark plugs are fouled or very worn
_____ c. some spark plugs have too narrow a gap
_____ d. there are no problems in the transistor ignition system

15. If an engine with a transistor ignition does not start, you would normally perform:

_____ a. a spark plug voltage test
_____ b. an available voltage test
_____ c. a cranking coil output test

16. Look at the following pattern from a cranking coil output test.



This pattern indicates that:

_____ a. there is a problem in the transistor ignition system
_____ b. there is no problem in the transistor ignition system

PART II: CHRYSLER

17. The Chrysler electronic ignition uses:

_____ a. no ballast resistor or resistor wire
_____ b. a single ballast resistor
_____ c. a single ballast resistance wire
_____ d. a dual ballast resistor

18. The steps below for testing a Chrysler electronic ignition are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Check battery capacity.
2. _____	b. Check ballast circuit.
3. _____	c. Check ignition coil.
4. _____	d. Check distributor pickup coil.
5. _____	e. Check all wiring and connections.
6. _____	f. Check distributor and hardware.
7. _____	g. Check ignition primary circuit.

19. In the Chrysler electronic ignition system, is the reluctor-pickup air gap adjustable?

_____ a. yes
_____ b. no

20. In the Chrysler electronic ignition system, the distributor pickup coil and ballast circuit are tested by using:

_____ a. an ohmmeter
_____ b. an ammeter
_____ c. a voltmeter
_____ d. an oscilloscope

21. In the Chrysler electronic ignition system, the primary circuit is tested by using:

_____ a. an ohmmeter
_____ b. an ammeter
_____ c. a voltmeter
_____ d. an oscilloscope

22. In the Chrysler electronic ignition system, the electronic control module is grounded by:

_____ a. its mounting on the firewall
_____ b. a wire running to the coil
_____ c. a wire running to the distributor

PART III: FORD

23. The Ford solid-state ignition system uses:

_____ a. no ballast resistor or resistor wire
_____ b. a single ballast resistor
_____ c. a single ballast resistance wire
_____ d. a dual ballast resistor

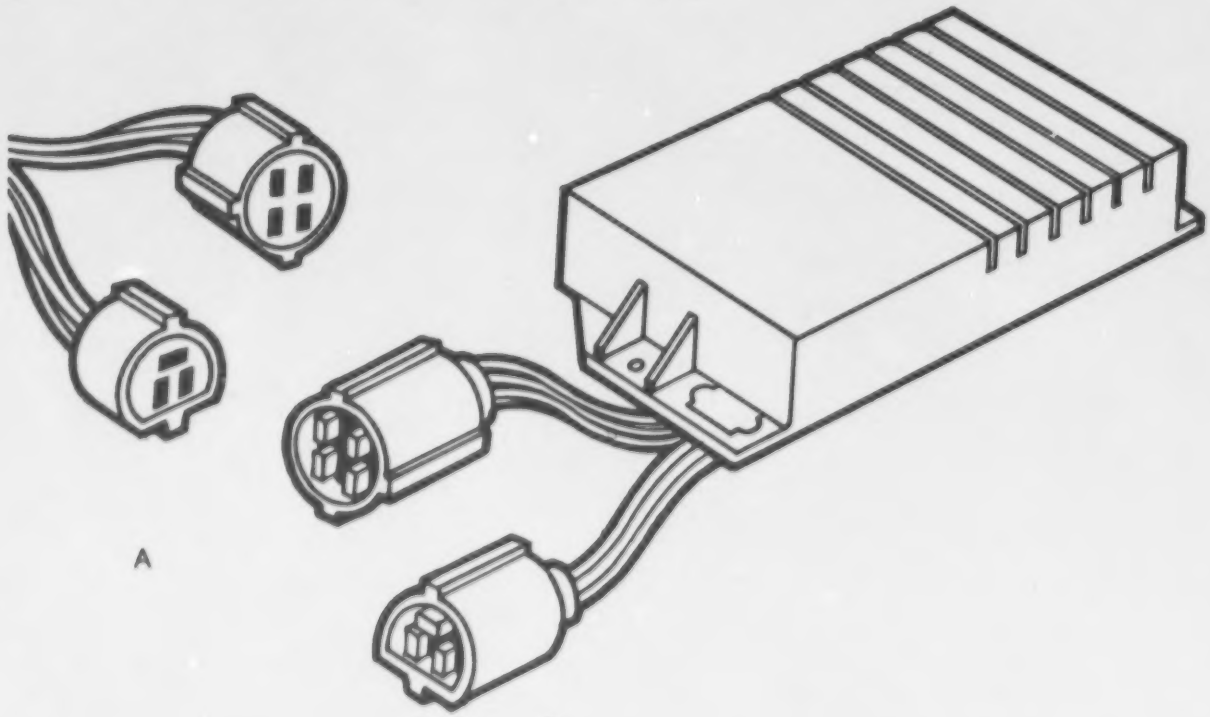
24. The steps below for testing a Ford solid-state ignition are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Make voltmeter tests.
2. _____	b. Check wiring and connections.
3. _____	c. Check distributor.
4. _____	d. Check battery capacity.
5. _____	e. Make ohmmeter tests.
6. _____	f. Check spark intensity.

25. In the Ford solid-state ignition system, is the armature-pickup coil air gap adjustable?

_____ a. yes
_____ b. no

26. Look at this picture of a Ford solid-state ignition system.



The voltmeter tests for this system are performed on:

_____ a. the A side of the wiring harness
_____ b. the B side of the wiring harness
_____ c. both the A and B side of the wiring harness

27. In the Ford solid-state ignition, the DEC terminal on the wire is the same as:

_____ a. the secondary coil terminal in a conventional ignition system
_____ b. the primary coil (+) terminal in a conventional ignition system
_____ c. the primary coil (−) terminal in a conventional ignition system

28. In the Ford solid-state ignition system, all ohmmeter tests are made with:

_____ a. the ignition off
_____ b. the ignition on
_____ c. the ignition on and the engine cranking

PART IV: GM

29. The GM high-energy ignition system uses:

_____ a. no ballast resistor or resistor wire
_____ b. a single ballast resistor
_____ c. a single ballast resistance wire
_____ d. a dual ballast resistor

30. The steps below for testing a GM high-energy ignition system are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Check for battery voltage at distributor.
2. _____	b. Check all spark plug wires.
3. _____	c. Check distributor cap and coil.
4. _____	d. Check wiring connector at side of distributor cap.
5. _____	e. Make pickup coil tests.
6. _____	f. Check battery capacity.

31. On a GM engine that has high-energy ignition and that starts but runs roughly, which of the following would you check first?

_____ a. timing advance
_____ b. electronic control module
_____ c. battery voltage at the distributor
_____ d. the magnetic armature

32. Which of the general cautions listed below should you follow when testing a GM high-energy ignition system?

_____ a. When using a timing light, do not pierce the spark plug wire.
_____ b. Turn ignition off when testing compression.
_____ c. Bypass the coil when checking available voltage output.
_____ d. Replace the electronic control module before checking the pickup coil.

33. Which GM engines with high-energy ignition have the coil mounted separately from the distributor assembly?

_____ a. the 4-cylinder engines
_____ b. the L-6 engines
_____ c. the V-6 engines
_____ d. the V-8 engines
_____ e. the 4-cylinder and L-6 engines
_____ f. the V-6 and V-8 engines

PART V: GENERAL DISTRIBUTOR SERVICING

34. When should you replace the electronic control module in the three types of transistor ignitions covered in this unit?

_____ a. after replacing the ignition coil
_____ b. after testing all other components of the ignition system
_____ c. after testing the spark plugs and spark plug wires
_____ d. when the vehicle engine will start, but runs poorly
_____ e. when the vehicle engine will not start

35. The steps below for replacing the pickup coil on a Ford solid-state ignition system are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Remove snap ring that secures vacuum advance link to pickup assembly.
2. _____	b. Disconnect distributor harness connector at distributor; remove wiring plug hold-down screw.
3. _____	
4. _____	c. Install new pickup assembly.
5. _____	d. Remove armature from distributor shaft.
6. _____	e. Remove distributor cap and rotor.
7. _____	f. Remove roll pin and wire retaining clip.
	g. Remove pickup coil retaining screws and pickup coil.

36. The steps below for replacing an electronic control module for a GM high-energy ignition are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Disconnect module connector and pickup coil leads from module terminals.
2. _____	
3. _____	b. Disconnect wiring harness connector at side of distributor.
4. _____	c. Install new module.
5. _____	d. Remove distributor cap and rotor.
6. _____	e. Remove mounting screws, and remove module.
	f. Coat bottom of module with dielectric lubricant.

37. The steps below for replacing the coil on a GM V-6 engine with high-energy ignition are out of order. Place the letter of each step in the blank by the proper number to show the correct sequence.

Order	Steps
1. _____	a. Push coil leads out of position in the distributor cap.
2. _____	b. Remove screws holding coil to distributor cap.
3. _____	c. Install new coil.
4. _____	d. Disconnect harness connector and battery wire from side of distributor cap.
5. _____	
6. _____	e. Remove coil.
	f. Remove screws holding coil cover to distributor cap, and remove cover.

38. When a GM high-energy ignition system has worn distributor shaft bushings, you should:

_____ a. replace the entire distributor housing
_____ b. install new bushings
_____ c. install a new distributor shaft and bushings
_____ d. ream out the old bushings and install a new distributor shaft

When you finish this pretest, carefully tear it out of the book and give it to your instructor. After s(he) has checked your answers, your instructor will direct you to either practice the work activities or to study the material covered by this test.

EXERCISE 17

1. Present-day ignition systems that use electronics and solid-state parts are called _____ ignition systems.
2. Ford Motor Company calls their new ignition system a/an _____ system.
3. Chrysler Corporation named their ignition system a/an _____ system.
4. General Motors Corporation calls their ignition system a/an _____ _____ _____ system.
5. Check each correct answer. The newer transistor ignition systems do not use:
   _____ a. distributors
   _____ b. rotors
   _____ c. condensers
   _____ d. contact points
   _____ e. distributor cam assemblies
6. The electronic control module controls the flow of primary current to the _____.
7. The distributor operation is controlled by a/an _____ _____.
8. The transistor ignition system in which the coil and the electronic control module are part of the distributor is the high-energy ignition system for GM _____ and _____ engines.
9. If the rotating armature in the distributor has six teeth, it is for:
   _____ a. a V-8 engine
   _____ b. a 4-cylinder engine
   _____ c. a 6-cylinder engine

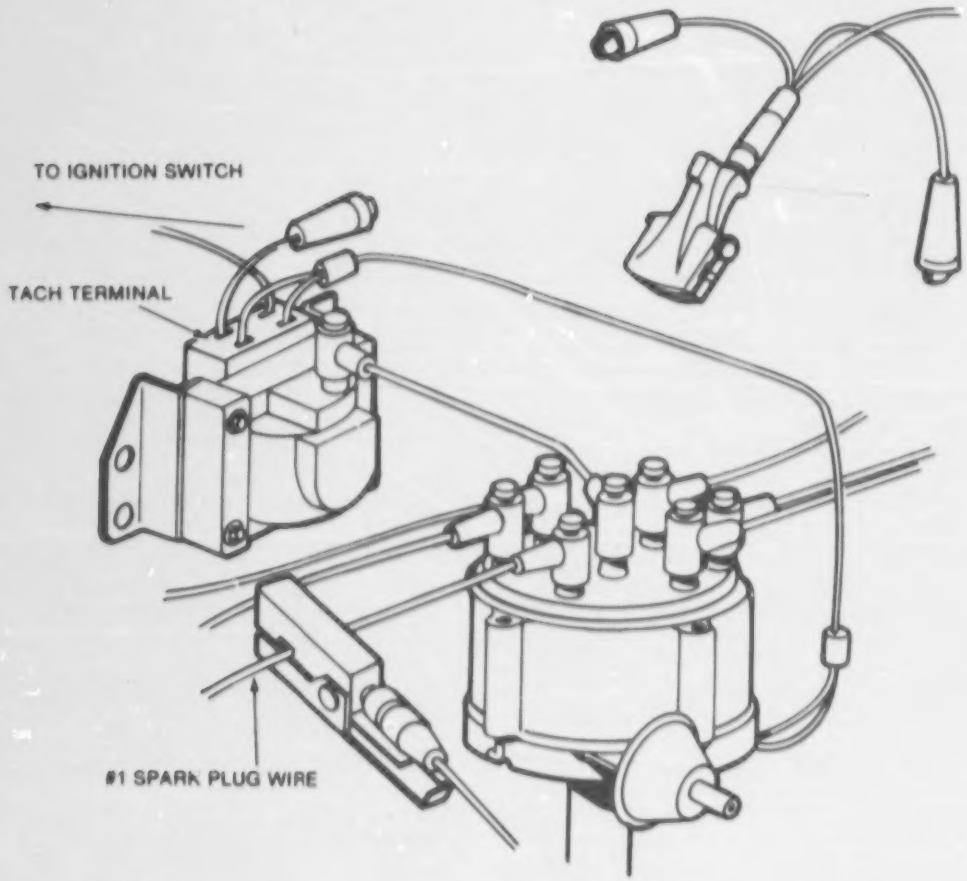
For questions 10-13, write *T* in the blank if the statement is true, and *F* if the statement is false.

10. _____ An electrical signal is generated in the pickup coil when the rotating armature is aligned with the stationary pole piece.
11. _____ The coil discharges the high voltage in the secondary circuit to the spark plug when the rotating armature is aligned with the stationary pole piece.
12. _____ One of the advantages of an electronic ignition system is the improved spark plug service intervals.
13. _____ Another advantage of the electronic ignition system is the absence of a rubbing block that could wear and change point dwell and engine timing.

14. In the blanks below, make a check mark next to each ignition part that is used in both a conventional ignition system and in a transistor ignition system.

a.	_____	distributor
b.	_____	distributor cap
c.	_____	coil
d.	_____	rotor
e.	_____	contact points
f.	_____	cam
g.	_____	condenser
h.	_____	vacuum advance mechanism
i.	_____	rubbing block
j.	_____	mechanical advance mechanism
k.	_____	spark plugs
l.	_____	spark plug wires

15. The drawing below shows a General Motors high-energy ignition system. On the drawing, show how the scope primary leads should be connected to an L6 or 4-cylinder engine.



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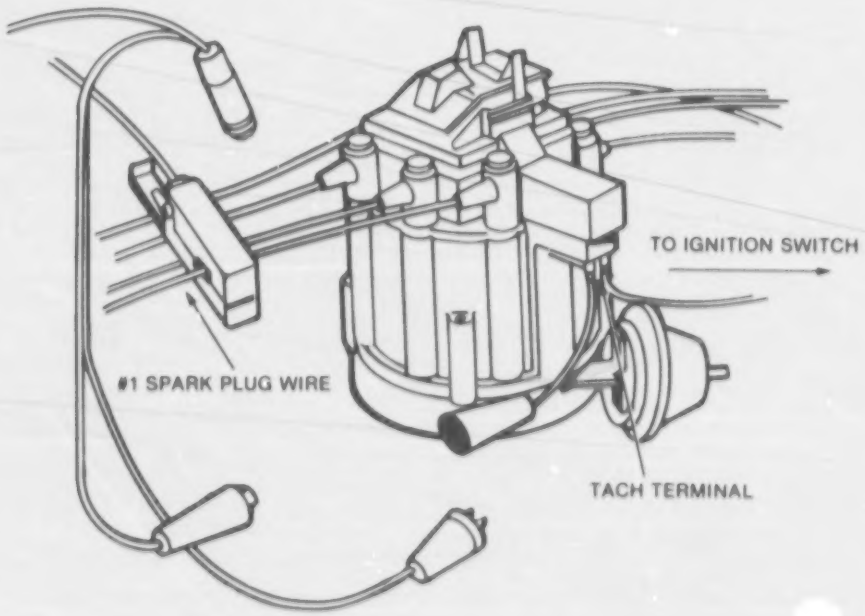
16. The drawing below shows a General Motors high-energy ignition system. On the drawing, show how the scope primary leads should be connected to a V-8 or V-6 engine.



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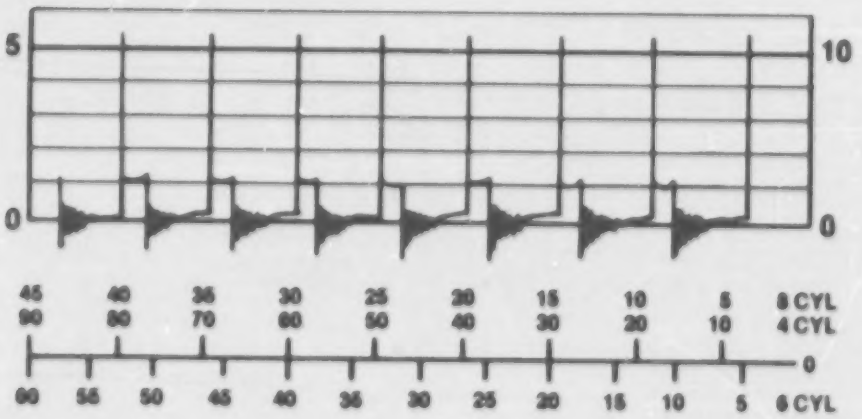
Now turn to the back of this book and check your answers for Exercise 17.

EXERCISE 18

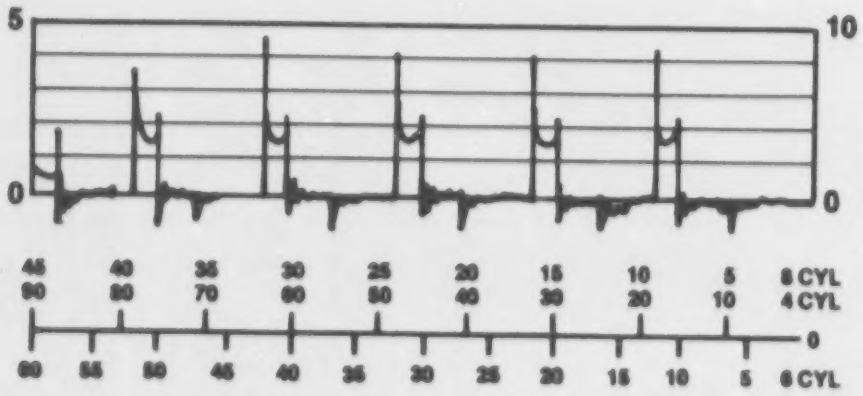
For questions 1-4, write *T* in the blank if the statement is true, and *F* if the statement is false.

1. _____ Transistor ignition scope patterns are exactly like those of a conventional ignition system.
2. _____ It is possible to measure voltages and study waveform patterns of transistor ignition systems just as you would for a conventional ignition system.
3. _____ The firing lines and the spark lines of a transistor ignition pattern are identical to those of a conventional ignition system.
4. _____ The transistor pattern has an intermediate section and a dwell section.
5. Identify the kind of transistor ignition system that has this display pattern:



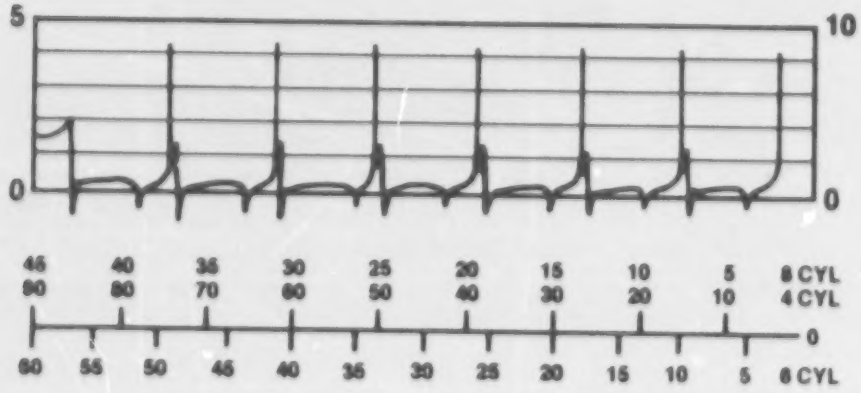
Kind of system: _____

6. Identify the kind of transistor ignition system that has this display pattern:



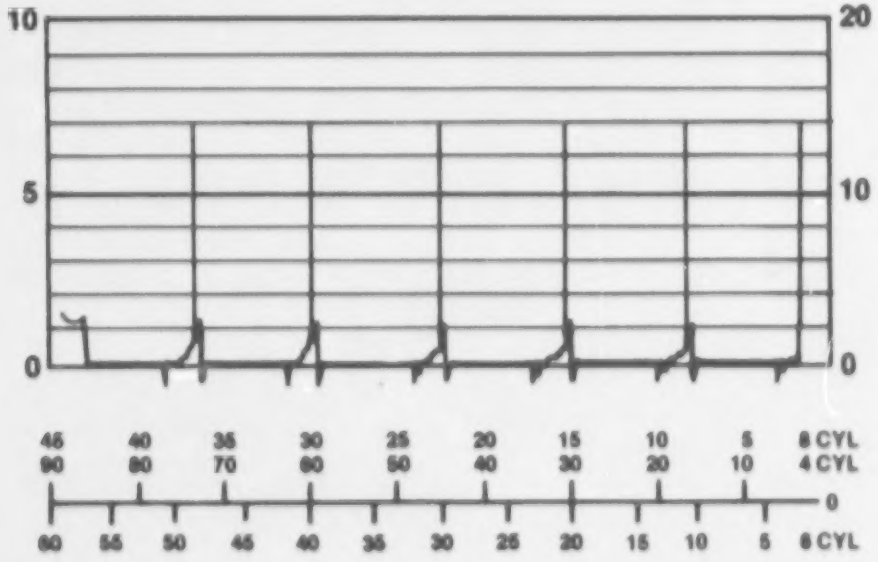
Kind of system: _____

7. Identify the kind of transistor ignition system that has this display pattern:



Kind of system: _____

8. Identify the kind of transistor ignition system that has this display pattern:



Kind of system: _____

9. The three conditions that indicate a possible malfunction in the transistor ignition system are:

a. _____

b. _____

c. _____

10. If the engine operates, the three scope tests that can be done to analyze transistor ignition malfunctions are:

a. _____

b. _____

c. _____

11. If the engine will not start, you need to do a _____ test.

12. The spark plug firing line (available voltage test) should be _____ kv or more for all but HEI systems.

13. During the available voltage test, the lower part of the pattern should be equal to at least _____ and should hold steady.

14. The lower part of the pattern (available voltage test) is a test of the _____ condition in the secondary circuit.

15. The spark plug firing line (in the cranking coil output test) should be _____ kv or more on GM high-energy ignition systems.

Now turn to the back of this book and check your answers for Exercise 18.

EXERCISE 19

1. Regular ignition maintenance on a transistor ignition system involves only three areas:

   a. _____

   b. _____

   c. _____

2. Chrysler's electronic ignition system provides a/an _____ _____ adjustment in the distributor.

3. When testing the distributor pickup coil, the ohm resistance reading should be _____ ohms when measured at the control unit wiring harness connector between the # _____ and # _____ terminals.

4. A/an _____ feeler gauge is specified when you measure the gap between the reluctor and the pickup coil.

5. List the necessary steps for adjusting the Chrysler distributor air gap.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

6. If you cranked the engine and saw the reluctor hit the magnetic pole piece as the reluctor rotated, this means that _____ _____.

7. If you cranked the engine and saw that only one part of the reluctor hit the magnetic pole piece, this means that _____ _____.

8. Whenever you remove or install a Chrysler wiring harness connector at the control unit, the ignition switch must be in the _____ position.

9. All primary ignition circuit tests are measured with a _____.

10. The specifications for each primary ignition circuit test (#1, #2, and #3) are within _____ _____ of normal battery voltage when all the accessories are turned off.

11. Complete the steps in the following procedure for doing detailed component tests and analyzing ignition malfunctions on the Chrysler system:

    a. wiring and connection checks

    b. _____

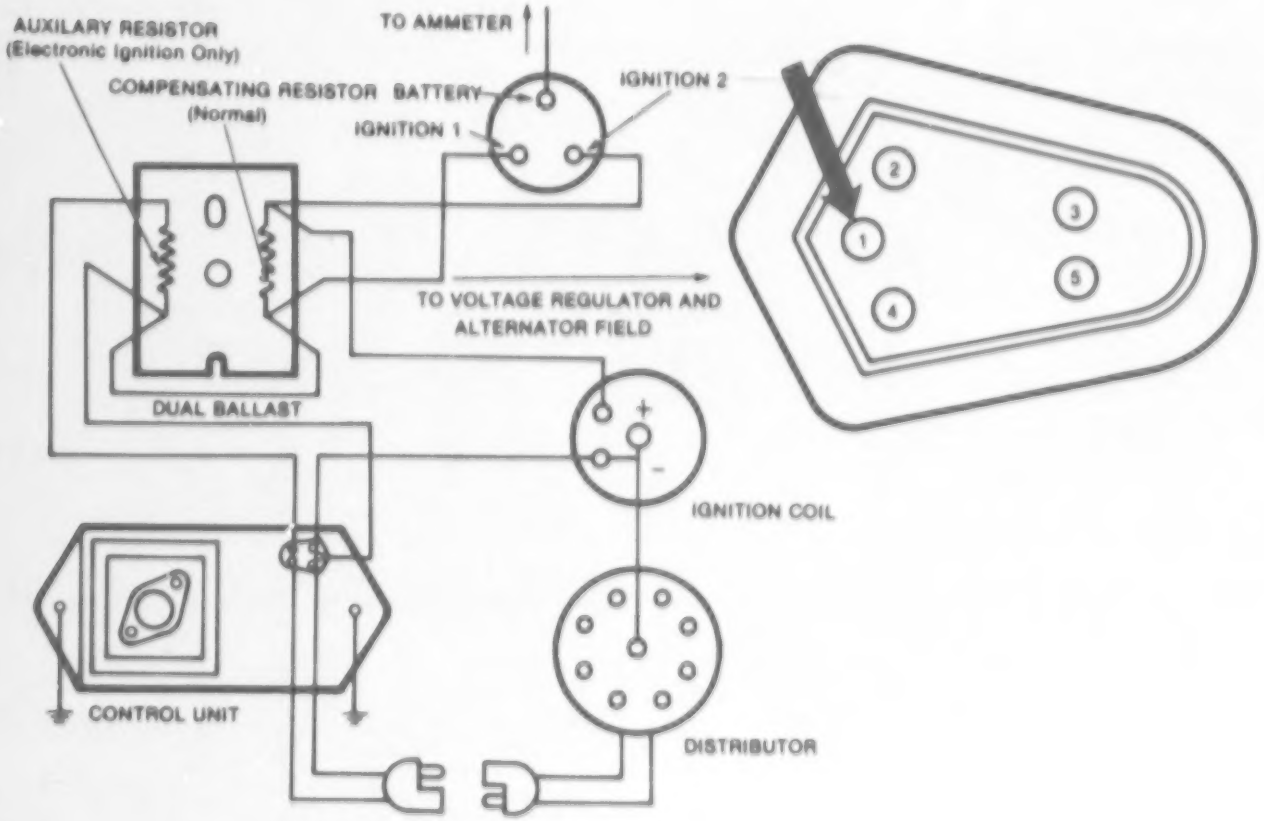
    c. _____

    d. ballast resistor tests

    e. _____

    f. coil test

12. In the diagram below, trace over the primary wiring circuit that connects with Terminal #1 in the wiring harness connector.



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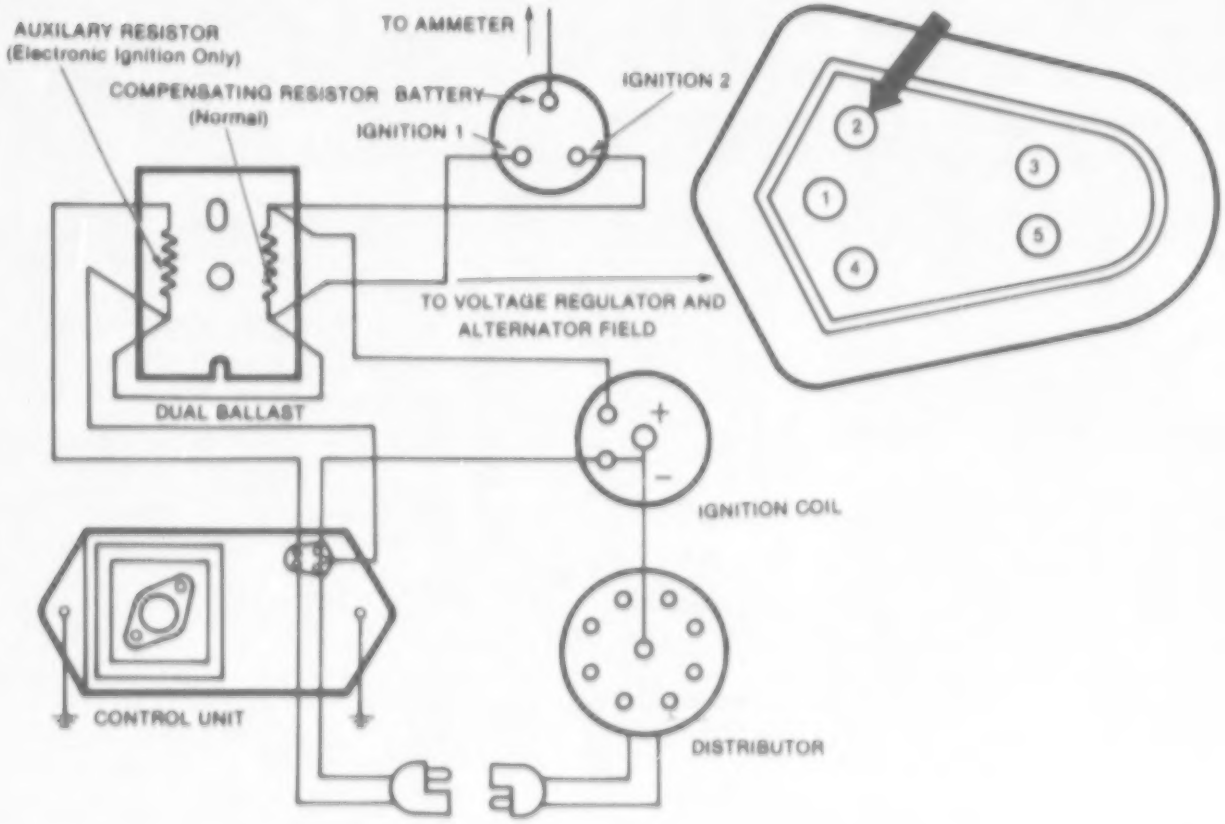
13. In the diagram below, trace over the primary wiring circuit that connects with Terminal #2 in the wiring harness connector.



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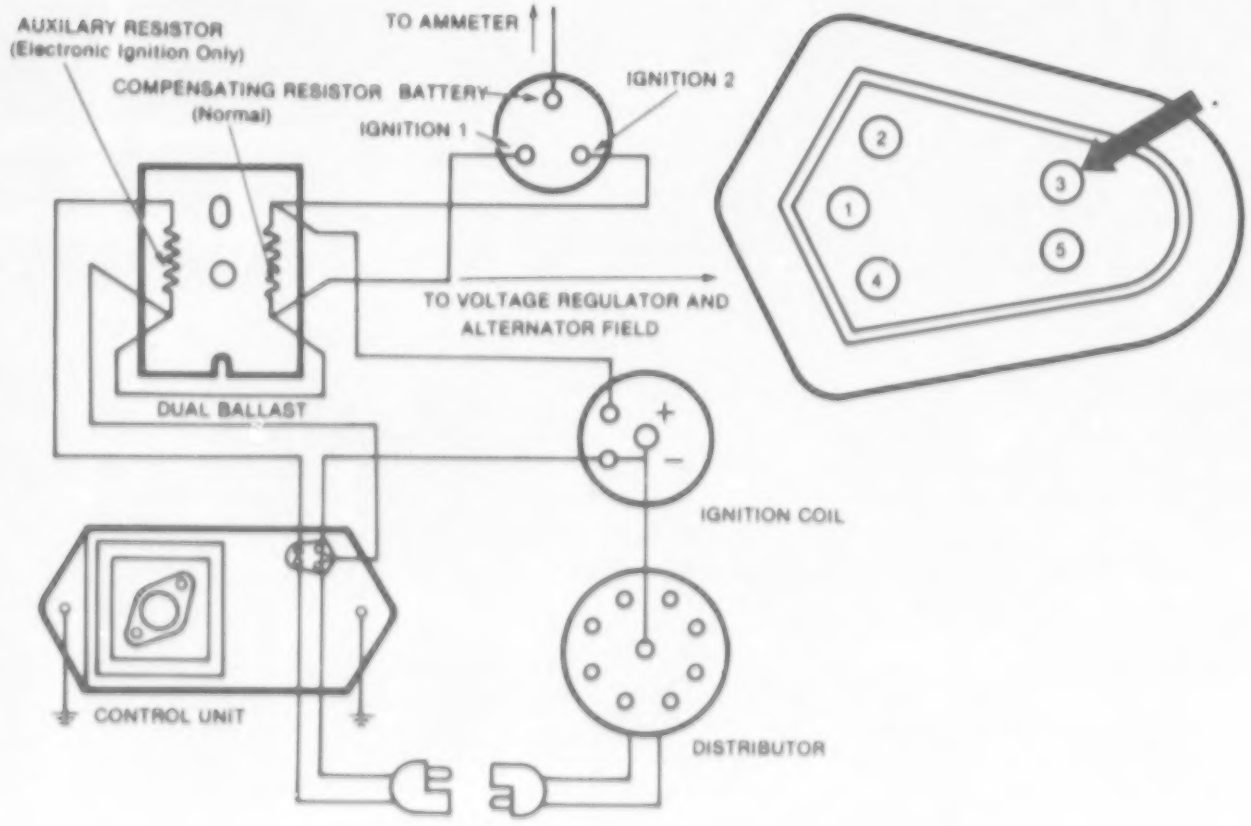
14. In the diagram below, trace over the primary wiring circuit that connects with Terminal #3 in the wiring harness connector.



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Now turn to the back of this book and check your answers for Exercise 19.

EXERCISE 20

1. The Ford solid-state ignition system consists of:

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. The first two detailed component checks are common to all transistor ignition systems. They are:

   a. _____

   b. _____

3. After you do the two tests mentioned in Question 2, Ford recommends that you do a _____ test on its solid-state ignition system.

4. All detailed voltmeter tests are made at the ignition _____ connectors.

5. Most of the voltmeter tests are made with the NEG (−) tester lead attached to _____ and the POS (+) tester lead connected to the correct _____ _____.

6. For the Ford solid-state ignition system, the detailed voltmeter tests are:

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

7. For the Ford solid-state ignition system, the detailed ohmmeter tests are:

   a. _____

   b. _____

   c. _____

   d. _____

8. To check the old module, plug in a _____ and do a _____ test.

For questions 9-10, write *T* in the blank if the statement is true, and *F* if the statement is false.

9. _____ It is necessary to do all the detailed voltage tests even though the ignition problem is corrected after the first test.

10. _____ It is necessary to do all the detailed ohmmeter tests even though the ignition problem is corrected after the first test.

Now turn to the back of this book and check your answers for Exercise 20.

EXERCISE 21

1. On General Motors V-8 and V-6 engines, the high-energy ignition distributor combines the following electronic ignition parts:

   a. _____

   b. _____

   c. _____

2. Inside the distributor, the part that has internal teeth is called a/an _____.

3. Inside the distributor, the part that has external teeth is called a/an _____.

4. On General Motors L-6 and 4-cylinder engines, the _____ is mounted separately from the distributor.

5. In analyzing GM's high-energy ignition system troubles, there are two engine conditions that determine the kind of detailed tests to do. They are:

   a. _____

   b. _____

6. Although the engine will not start, a spark intensity test was good. You should now check:

   a. _____

   b. _____

   c. _____

7. The engine will not start, and a battery voltage test at the distributor was bad. You should proceed to _____ testing.

8. The high-energy ignition detailed component tests involve the following ignition parts:

   a. _____

   b. _____

   c. _____

   d. _____

9. To do the tests mentioned in Question 8, a/an _____ is used.

10. When the coil is removed from the distributor cap, you inspect for _____ at the spring and seal.

11. To do a pickup coil test, you must disconnect the leads from the _____ to the _____.

12. During the pickup coil test, you must also operate the _____ _____ through the specification range.

13. On the pickup coil test, the ohmmeter should read:

_____ a. 250-450 ohms
_____ b. 500-600 ohms
_____ c. 650-850 ohms
_____ d. 850-950 ohms

14. Check each correct answer. When the engine starts but runs roughly, you should inspect the following first.

_____ a. proper fuel delivery
_____ b. vacuum lines
_____ c. engine initial timing
_____ d. centrifugal timing advance
_____ e. spark plugs
_____ f. air conditioner
_____ g. alternator belt
_____ h. electronic module

15. When the engine starts but runs roughly, you should replace the _____ if the problem continues after all other tests and repairs have been made.

Now turn to the back of this book and check your answers for Exercise 21.

EXERCISE 22

For questions 1-11, write *T* in the blank if the statement is true, and *F* if the statement is false.

1. _____ The transistor distributor is removed and installed in the same manner as is a conventional distributor.
2. _____ The transistor distributor can be tested on a distributor tester.
3. _____ The air gap on the Chrysler electronic distributor can be adjusted while on the distributor tester.
4. _____ Generally, timing advance mechanisms are the main parts tested on a distributor tester.
5. _____ The transistor distributor is installed with the engine timing marks aligned.
6. _____ The pickup coil can be replaced in transistor distributors.
7. _____ The pickup coil assembly on Chrysler's electronic ignition system is part of the distributor upper plate and is replaced with it.
8. _____ In order to replace the pickup coil assembly of the Chrysler electronic ignition system, the reluctor must be removed.
9. _____ In order to replace the pickup coil assembly of the Ford solid-state ignition system, the armature must be removed.
10. _____ In order to replace the pickup coil assembly of GM's high-energy ignition distributor, the distributor shaft must be removed.
11. _____ To remove the electronic module of either Chrysler or Ford's electronic ignition systems, simply disconnect the wiring harness and remove the module mounting bolts.
12. List the steps to follow when removing the GM high-energy ignition system's electronic module.

    a. _____

    b. _____

    c. _____

    d. _____

    e. _____

For questions 13-15, write *T* in the blank if the statement is true, and *F* if the statement is false.

13. _____ The bottom of the GM electronic module must be coated with dielectric lubricant before installation.
14. _____ The ignition coils of most transistor ignition systems are replaced just as are those of a conventional system.
15. _____ Transistor ignition distributors can be overhauled in a manner similar to that of a conventional distributor.

16. List the steps to follow when removing GM's high-energy ignition system coils for V-8 and V-6 engines.

a. _____

b. _____

c. _____

Now turn to the back of this book and check your answers for Exercise 22.

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PERFORMANCE CHECKLIST—P.O. 22

Your instructor will provide either a live vehicle or live engine equipped with a transitor ignition system for this objective. Test the transistor ignition system and repair any malfunctions you find. All necessary tools, equipment, and manuals will be made available.

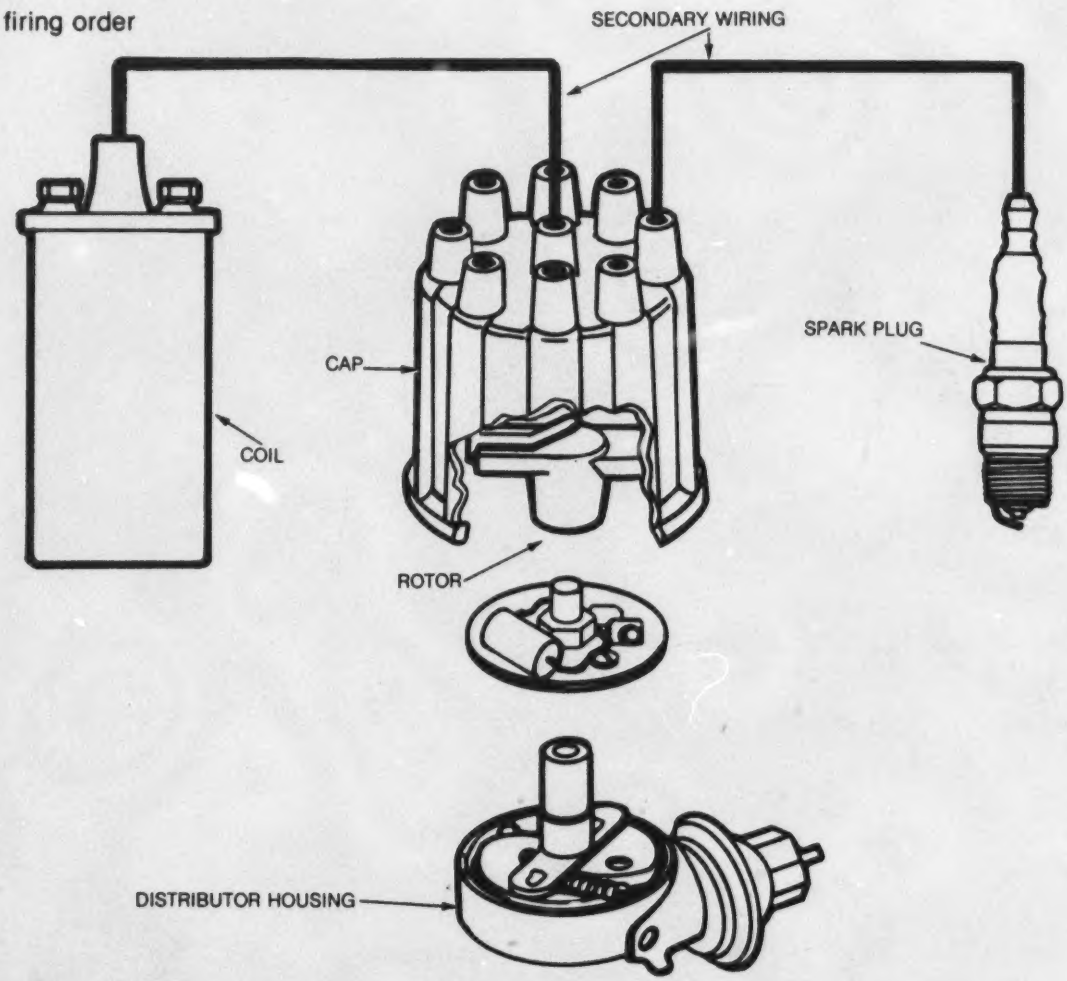
Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Visually inspects all wiring and connections.			
2. Checks battery capacity, and records results.			
3. Checks scope patterns and spark plug firing voltages, using an engine analyzer; records results.			
4. Checks available voltage output, and records results.			
5. Follows manufacturer's detailed component testing procedures, and records results.			
6. Repairs or replaces defective parts as necessary.			
7. Uses proper tools and equipment.			
8. Follows all appropriate safety precautions.			
9. Does performance in an acceptable amount of time.			

Keep a copy of this checklist for your records.

ANSWERS TO EXERCISES

ANSWERS TO EXERCISE 1

1. secondary circuit
2. spark plug
3. a. coil
   b. distributor
   c. distributor cap
   d. rotor
   e. high-tension cables
   f. spark plugs
4. center
5. rotor
6. firing order
7.



Now return to page 8 in your Student Guide.

ANSWERS TO EXERCISE 2

1. flashover or arc-over
2. carbon track
3. The dirt could fall into the distributor and foul the operation of either the breaker plate assembly *or* the contact points.
4. You can stretch or crimp the ignition wires and damage the terminals on the ends of the wires.
5. ignition, high-tension
6. a. conductor
   b. insulation
   c. jacket
7. yarn, carbon
8. heat, oily, exhaust
9. damp cloth, mild detergent
10. T
11. T
12. T
13. T
14. T
15. T
16. T
17. 1-5-4-2-6-3-7-8
18. 1-8-4-3-6-5-7-2
19. 1-5-3-6-2-4

Now return to page 19 in your Student Guide.

ANSWERS TO EXERCISE 3

1. twist
2. seal
3. peel
4. insulated pliers
5. #1 spark plug

6. a. locking tabs
   b. metal clip
   c. conductor
   d. secondary wire
   e. center conductor tab
7. a. loosely connected metal clips
   b. broken clips
   c. corroded clips
8. length
9. damaged or broken
10. T

Now return to page 24 in your Student Guide.

ANSWERS TO EXERCISE 4

1. T
2. T
3. T
4. T
5. F
6. T
7. T
8. T
9. T

Now return to page 29 in your Student Guide.

ANSWERS TO EXERCISE 5

1. T
2. T
3. T
4. T
5. F
6. T

7. T
8. T
9. T

Now return to page 35 in your Student Guide.

ANSWERS TO EXERCISE 6

1. You can damage or break the spark plugs, making them unserviceable.
2. a. 1
   b. 2
   c. 4
   d. 3
   e. 5
3. T
4. F
5. T
6. T
7. T
8. T
9. Replace
10. Clean
11. Clean
12. Replace
13. Clean
14. Clean

Now return to page 47 in your Student Guide.

ANSWERS TO EXERCISE 7

1. F
2. T
3. T
4. T

5. T
6. T
7. T
8. T
9. T
10. T
11. T
12. T
13. b

Now return to page 54 in your Student Guide.

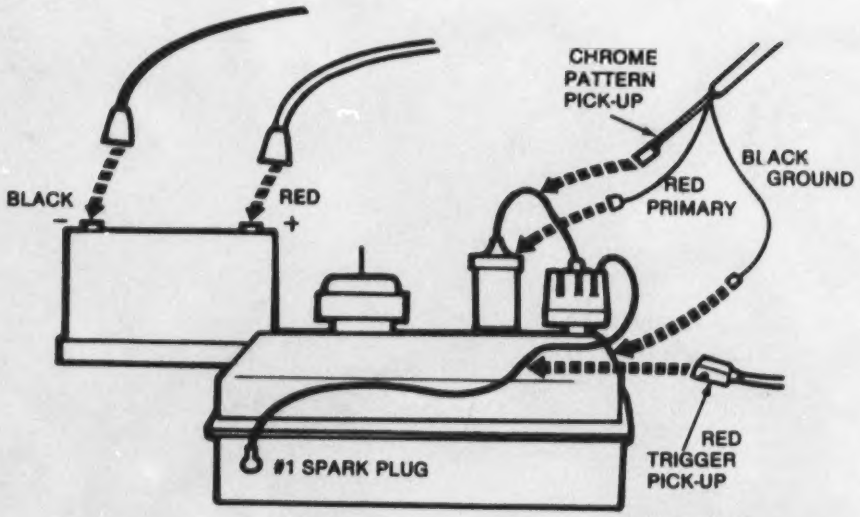
ANSWERS TO EXERCISE 8

1. d, b, e
2. length
3. cold
4. hot
5. insulator
6. torque wrench
7. gap
8. overheat
9. a. 1
   b. 5
   c. 4
   d. 2
   e. 3
10. remove
11. decrease

Now return to page 61 in your Student Guide.

ANSWERS TO EXERCISE 9

1.



2. a. Connect the black, negative lead to the NEG (–) battery terminal.
   b. Connect the red, positive lead to the POS (+) battery terminal.
   c. Attach the chrome pattern pickup around the coil high-tension wire.
   d. Connect the red primary tester lead to the DIST (–) terminal of the coil.
   e. Connect the black primary ground tester lead to ground on the engine block.
   f. Clamp the red trigger pickup around the #1 spark plug wire near the distributor cap.
3. Good
4. Good
5. Bad
6. Bad
7. Good
8. display
9. firing
10. b
11. e
12. c

Now return to page 80 in your Student Guide.

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ANSWERS TO EXERCISE 10

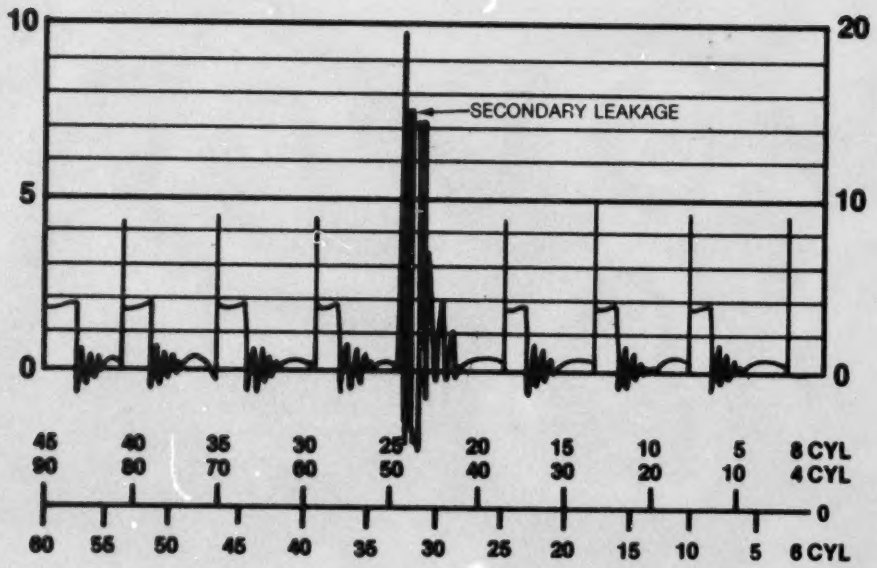
1. F
2. T
3. Good
4. 5 kv, 15 kv, 3 kv
5. #3
6. e
7. 7
8. d
9. a, b, c, d, e, f
10. a, b, c, d, e, f
11. a, b, c, d
12. a. connectors
    b. jumper lead, Resistance Test Contactor
    c. 1,000, connector
13. spark plug, cylinder
14. plug wire, distributor cap

Now return to page 94 in your Student Guide.

ANSWERS TO EXERCISE 11

1. firing lines
2. Good
3. yes
4. 1,500, distributor cap

5.



6. ground, distributor terminal
7. 8 kv
8. 8 kv

Now return to page 100 in your Student Guide.

ANSWERS TO EXERCISE 12

1. firing
2. a. oily combustion chamber
   b. carbon-fouled spark plug
3. 5
4. leaking exhaust valve
5. 3
6. fuel starvation, retarded timing

Now return to page 107 in your Student Guide.

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ANSWERS TO EXERCISE 13

1. performance
2. equal
3. engine analyzer
4. temperatures
5. STEP 1 Connect the engine analyzer to the engine.
   STEP 2 Select the scope secondary display pattern and the 40 kv scale.
   STEP 3 Set the anaiyzer RPM meter on the 1,200 RPM scale.
   STEP 4 Set the cylinder switch for the number of cylinders in the engine.
   STEP 5 Start the engine and let it warm up.
   STEP 6 Set the engine speed at a steady 800-to-1,000 RPM.
6. STEP 7 Press the first button to short out the #1 spark plug. Write down the RPM reading.
   STEP 8 Press the cancel button to return the cylinder to normal operation.
   STEP 9 Press other cylinder buttons to short each of the other spark plugs in turn.
   STEP 10 Write down the low RPM readings for each cylinder and compare the readings for all cylinders.
7. cancel (or cylinder), operation
8. variations
9. 30
10. 3

Now return to page 118 in your Student Guide.

ANSWERS TO EXERCISE 14

1. mechanical
2. electrical
3. below, cylinder, fouled spark plug
4. vacuum leak
5. blown head gasket
6. spark plug wire
7. spark plug, cylinder
8. cylinder
9. cylinder leakage

Now return to page 121 in your Student Guide.

ANSWERS TO EXERCISE 15

1. cylinder power balance
2. mechanical
3. compression
4. a. bad exhaust valve
   b. bad intake valve
   c. bad piston rings
   d. bad head gasket
   e. bad cooling system
5. T
6. T
7. T
8. T
9. T
10. STEP 1 Remove the spark plug(s).
    STEP 2 Remove the oil filler cap, radiator cap, and carburetor air cleaner. Set the throttle valve in the wide-open position.
    STEP 3 Ground the coil high-tension lead.
    STEP 4 Connect the remote start switch.
    STEP 5 Select spark plug adapters of the correct size.
    STEP 6 Install the spark plug adapter in the engine. Attach the whistle.
11. STEP 1 Crank the engine over until the piston reaches TDC. Remove the whistle.
    STEP 2 Connect the cylinder leakage tester hose to the hose on the spark plug adapter.
    STEP 3 Read the percent cylinder leakage gauge. Listen for air leakage at the engine openings.
12. 20 percent
13. c
14. a
15. d
16. b

Now return to page 136 in your Student Guide.

ANSWERS TO EXERCISE 16

1. cylinder power balance
2. mechanical

3. compression

4. a. bad engine valves
   b. bad piston rings
   c. bad head gasket

5. T

6. T

7. T

8. T

9. T

10. STEP 1 Remove all spark plugs.
    STEP 2 Remove the carburetor air cleaner. Block the throttle valve in the wide-open position.
    STEP 3 Ground the coil high-tension lead.
    STEP 4 Connect the remote starter switch to the solenoid or starter relay.
    STEP 5 Insert the compression gauge in the spark plug hole.
    STEP 6 Crank the engine over for four or five compression strokes to obtain the highest possible reading.
    STEP 7 Write down the compression readings of each cylinder.

11. 75 percent

12. more

13. c

14. b

15. c

Now return to page 148 in your Student Guide.

ANSWERS TO EXERCISE 17

1. transistor (or electronics)

2. solid-state ignition

3. electronic ignition

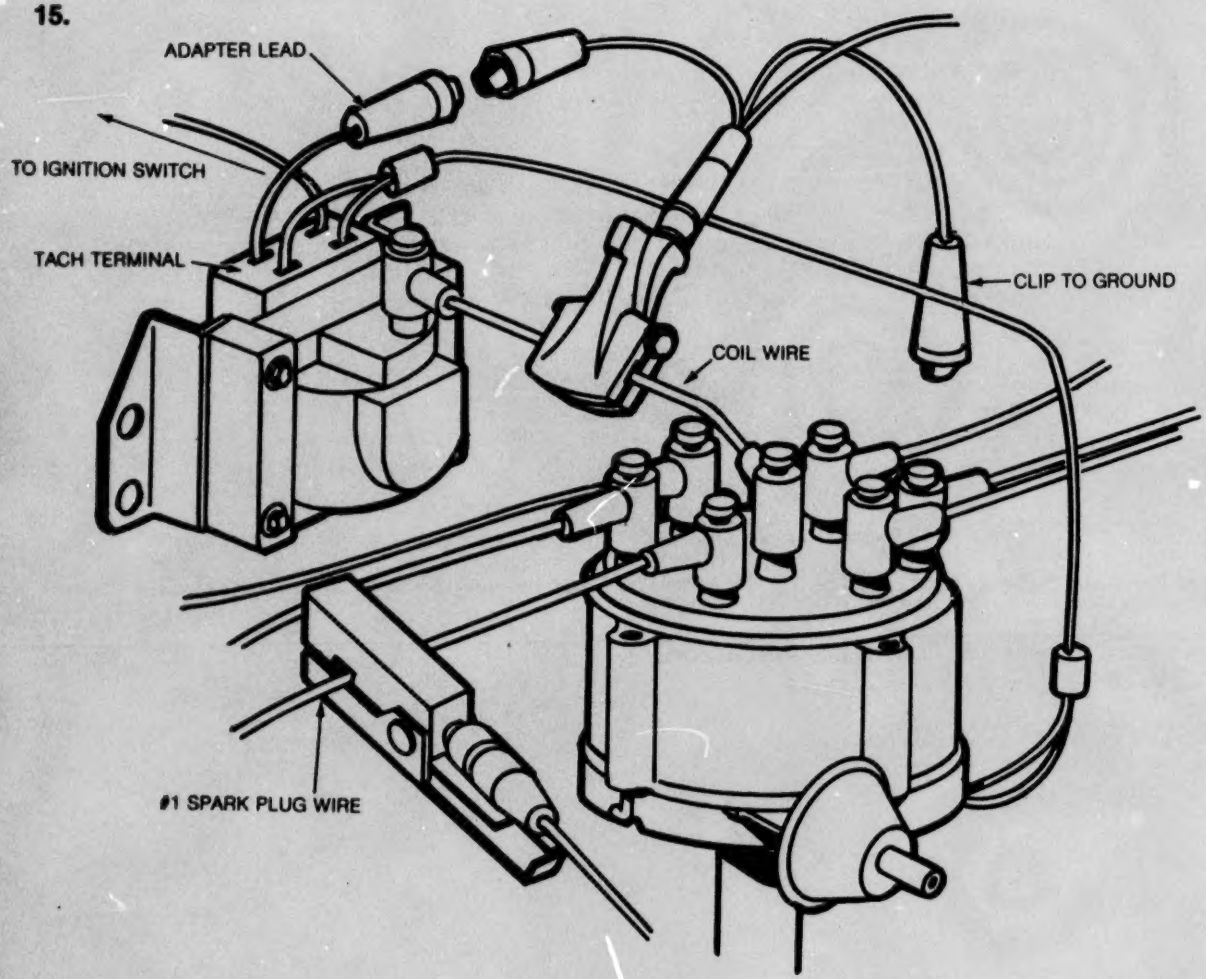
4. high-energy ignition

5. c
   d
   e

6. coil

7. electronic control module

8. V-8, V-6
9. c
10. F
11. T
12. T
13. T
14. a, b, c, d, h, j, k, l
15.



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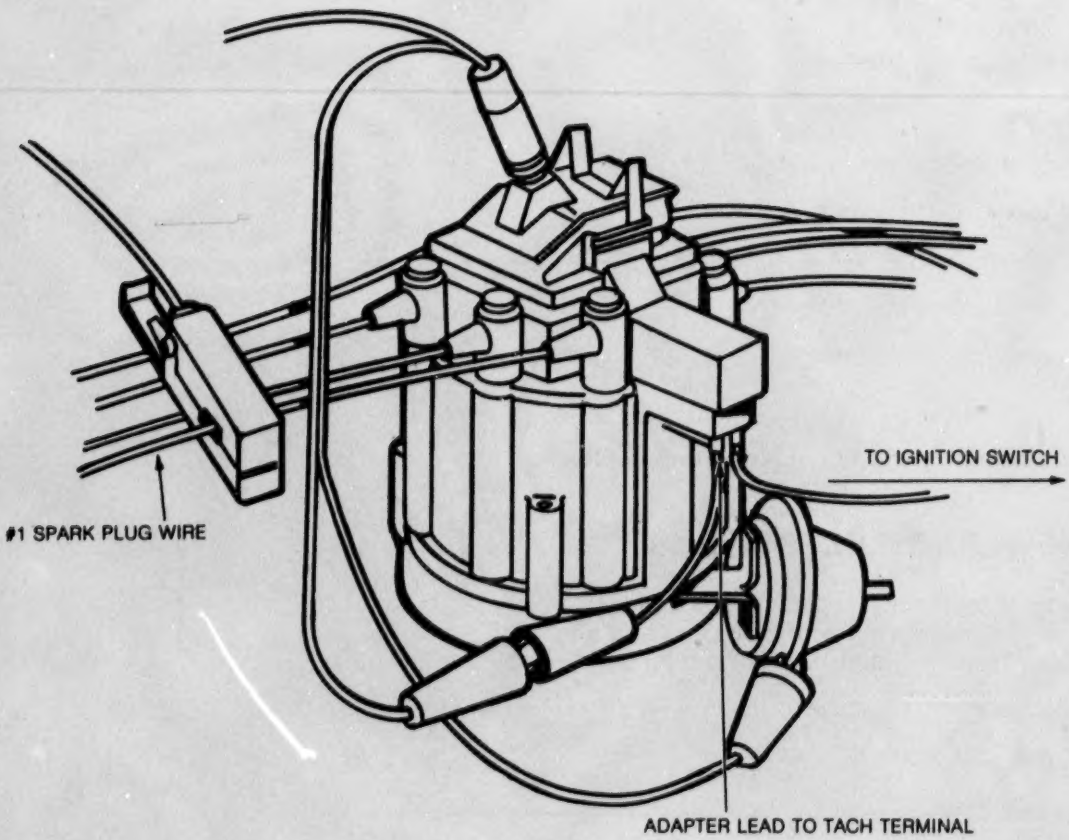
16.



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Now return to page 161 in your Student Guide.

ANSWERS TO EXERCISE 18

1. F
2. T
3. T
4. F
5. Chrysler's electronic ignition system
6. Ford's solid-state ignition system
7. GM's high-energy ignition system, V-8 engine

8. GM's high-energy ignition system, V-6 engine

9. a. engine surges severely
   b. engine misses
   c. engine will not start

10. a. available voltage test
    b. secondary insulation test
    c. spark plug firing voltage test

11. cranking coil output

12. 20 kv

13. one half the upward height

14. secondary insulation

15. 30 kv

Now return to page 171 in your Student Guide.

ANSWERS TO EXERCISE 19

1. a. cleaning and replacing spark plugs
   b. inspecting the distributor cap and rotor
   c. inspecting and testing the magnetic distributor and ignition wiring

2. air gap

3. 150-900, 4 and 5

4. .008

5. a. Remove the distributor cap and rotor.
   b. Align one tooth of the reluctor directly across the stationary pole piece.
   c. Install an .008" feeler gauge between the reluctor tooth and the pole piece.
   d. Loosen pickup hold-down screw. Move the pickup to adjust.
   e. Tighten the hold-down screw and remove the feeler gauge.

6. air gap is incorrect and needs adjusting

7. distributor shaft is bent

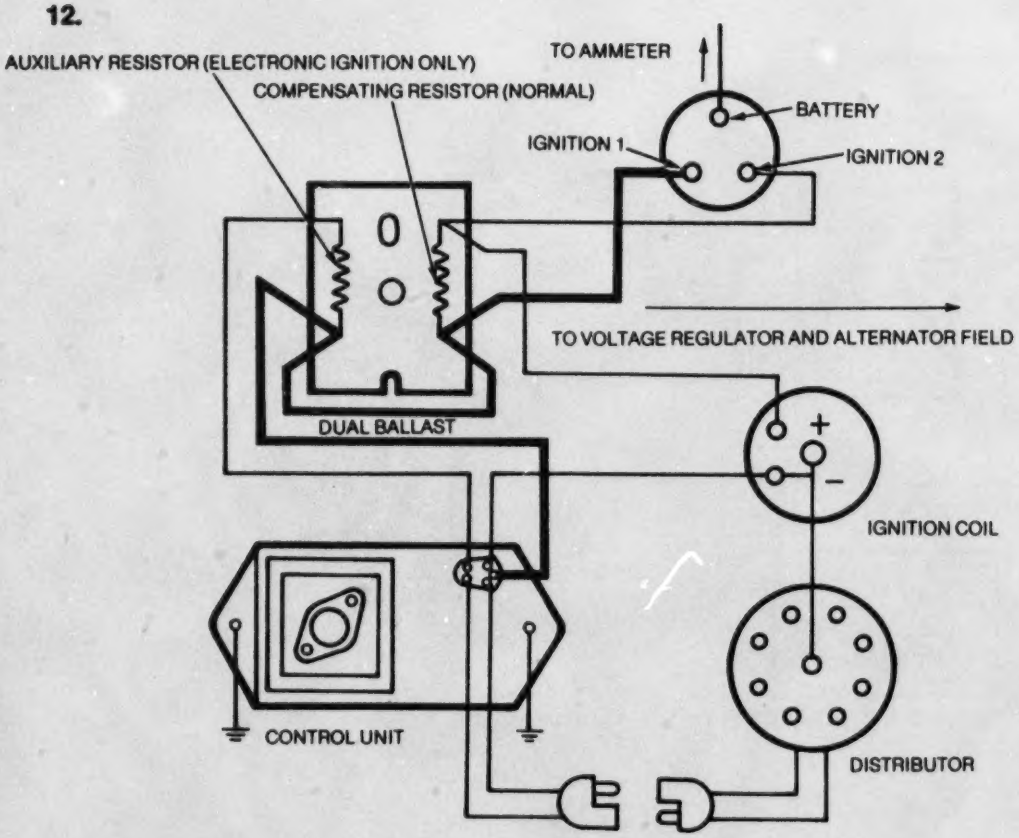
8. off

9. voltmeter

10. one volt

11. a. wiring and connection checks
    b. battery voltage test
    c. distributor tests
    d. ballast resistor tests
    e. ignition primary circuit tests
    f. coil test

12.



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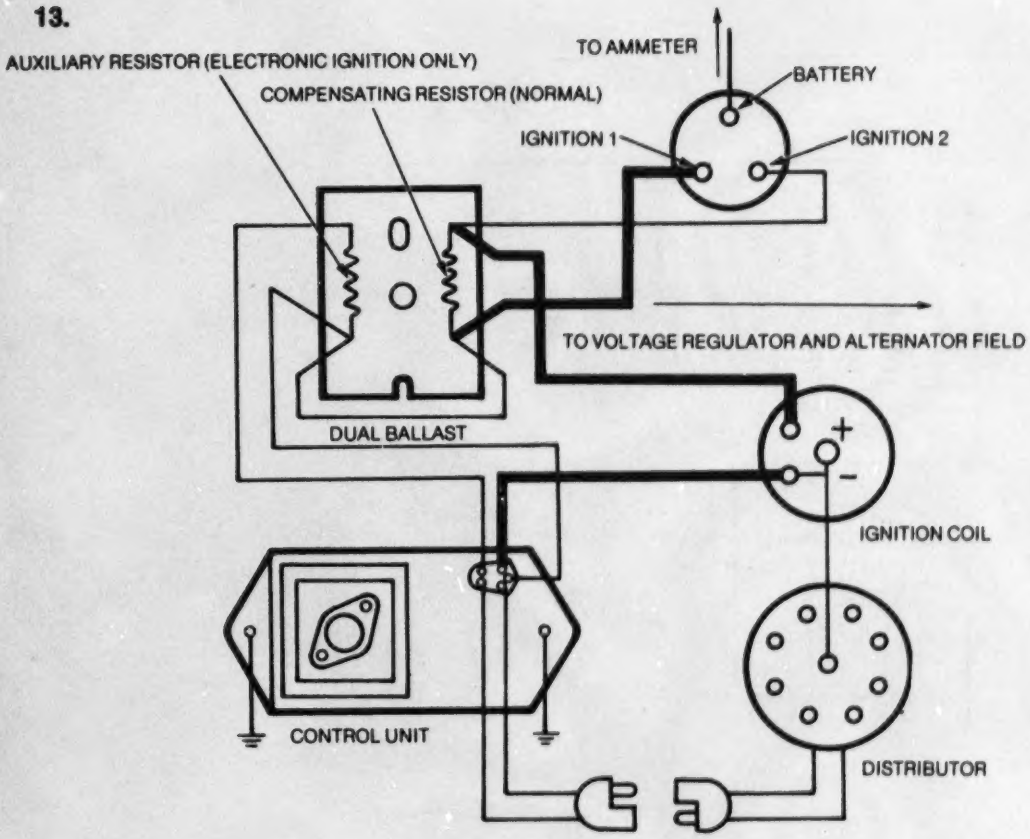
13.



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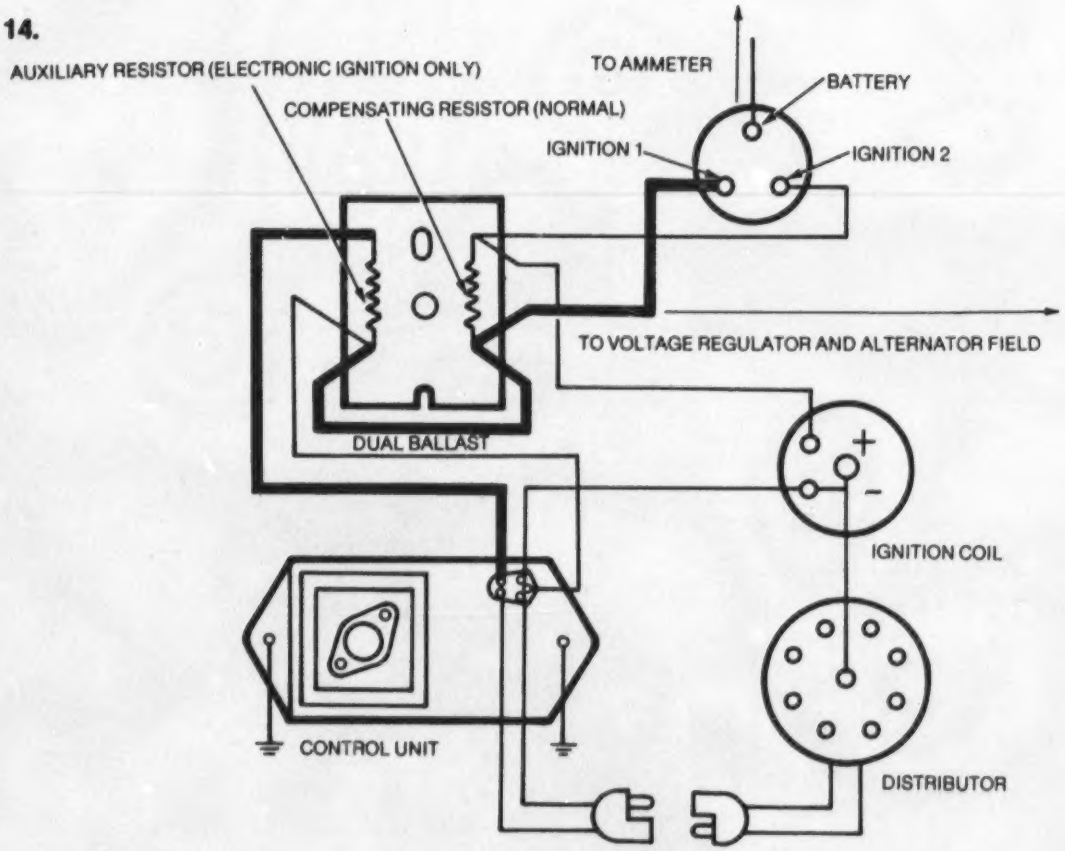
14.



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Now return to page 182 in your Student Guide.

ANSWERS TO EXERCISE 20

1. a. a magnetic distributor
   b. an electronic control module
   c. two wire harnesses
   d. a resistance wire
   e. an oil-filled coil
2. a. wiring and connections check
   b. battery voltage test
3. spark intensity
4. harness

5. ground, terminal pin

6. a. module bias test
   b. battery source test
   c. cranking test
   d. starting circuit test
   e. distributor hardware test

7. a. magnetic pickup tests
   b. ignition coil test
   c. short test
   d. resistance wire test

8. new module, spark intensity

9. F

10. F

Now return to page 197 in your Student Guide.

ANSWERS TO EXERCISE 21

1. a. ignition coil
   b. electronic module
   c. pickup coil

2. circular pole piece

3. timer coil

4. ignition coil

5. a. engine will not start
   b. engine starts but runs roughly

6. a. fuel system
   b. spark plugs
   c. secondary wiring

7. detailed component

8. a. distributor cap
   b. rotor
   c. ignition coil
   d. pickup coil

9. ohmmeter

10. arc-over

11. module, pickup coil

12. vacuum advance mechanism

13. c

14. a, b, c, d, e

15. electronic module

Now return to page 203 in your Student Guide.

ANSWERS TO EXERCISE 22

1. T

2. T

3. T

4. T

5. T

6. T

7. T

8. T

9. T

10. T

11. T

12. a. Disconnect the wiring harness at the distributor cap.
    b. Remove the distributor cap.
    c. Remove the rotor.
    d. Disconnect the pickup coil leads and the module connector at the module.
    e. Remove the module mounting screws.

13. T

14. T

15. T

16. a. Remove the coil cover from the distributor cap.
    b. Remove the coil mounting screws from the distributor cap.
    d. Disconnect the harness connector and the battery wire from the side of the distributor.

Now return to page 209 in your Student Guide.